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Annette Froehlich *Editor*

Space Security and Legal Aspects of Active Debris Removal

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Active Debris Removal: A Joint Task and Obligation to Cooperate for the Benefit of Mankind

Valentin Degrange

Abstract This analysis aims to prove that the cooperation of all spacefaring nations for the removal of space debris is not only a necessity in terms of the sustainable development of a limited natural resource, but could also constitute an obligation under international law. Furthermore, the establishment and observance by the international community of rules concerning space debris removal, as well as the creation of a dedicated international organization charged with dealing with these matters, could be one of the next steps in the development of mankind's space capabilities. The importance of securing humanity's doorstep to outer space cannot be overstated and should indeed be a priority for all nations. But will the international community take such a step?

1.1 Introduction

The cold war space race, which arguably began in 1957 with the launch of the first artificial satellite Sputnik 1, was an ideological race and involved only two real actors: the ex-USSR and the United States of America. At the time, the USA and the USSR both tried to assert their technical and scientific superiority over the other, which led to great advances from a technological as well as a legal point of view. The present situation is notably different.

First, the objectives have changed and the avowed goal of contemporary space exploration is mostly of a commercial nature. The pre-eminence of telecommunications in our modern society, and the increasing development of private activities in the space sector, have highlighted the intrinsic value of the "spectrum-orbit resource" and have seen the development of the commercialization of outer space by states. The exploitation of outer space for both scientific and economic purposes in the future is therefore more likely to rely on the private sector.

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Second, new players have emerged alongside the traditional space powers: China, India and Japan, for example, have considerably developed their space capabilities in recent years. They join the USA, Russia and the Member States of the European Space Agency in the fairly closed circle of spacefaring nations. Taking Europe as one "launching state", for calculation purposes, the number of states that actually engage in/license private companies to perform launches from their territory amounts to a total of 12 launching states.[1]

As space activities are undergoing a rapid development, the emergence of new prospects for the utilization and exploitation of outer space are making it increasingly "contested, congested and competitive".[2] Many aspects of our daily lives have already come to depend on our occupation of Low Earth Orbits (LEO) and Geostationary Earth Orbits (GEO). As the number of space-related activities increases exponentially, most notably for commercial purposes, so does the number of orbiting space debris that threaten to cause potentially irreparable damages. The "big sky" theory, which protected airborne travellers for almost two decades before becoming obsolete, will soon suffer the same fate in regard to space travel.

The future of space activities partially depends on the answer from the international community to this problem. As the number of space activities and debris grows exponentially, not only is it necessary to guarantee the sustainable development of outer space and Earth orbits, a limited natural resource, but it could also constitute an obligation under both international space[3] law and international law for spacefaring nations to cooperate in order to accomplish this. Furthermore, international involvement in the regulation-making process for space traffic management and space debris removal has been sparse, if not non-existent, save for a few non-binding documents. The adoption of an international treaty on space debris removal and the creation of a dedicated international organization is therefore an option that merits rapid consideration.

1.2 The Long-Term Sustainability of Outer Space Activities

As the number of actors involved in space exploration as well as the scope of their activities continues to increase, so does the number of space debris. Space traffic is increasing in a comparable way to that of air traffic during the twentieth century, but

[1] Peter Van Fenema, "Legal aspects of launch services and space transportation", *Handbook of Space Law*, Frans Von Der Dunk (dir.) with Fabio Tronchetti, Edward Elgar Publishing, 2015, 1100 p., p. 409.

[2] Lt. Col. S. Hunter, "How to reach an International Civil Aviation Organization role in Space Traffic Management" (November 5, 2014), *Space Traffic Management Conference,* 21p., p. 5. URL: http://commons.erau.edu/stm/2014/wednesday/21.

[3] *Treaty* on *Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, 27 January 1967 (entered into force on 10 October 1967), Article IX. URL: http://www.unoosa.org/pdf/gares/ARES_21_2222E.pdf.

dangerous debris was never an issue for the latter. While aviation collisions between two aircraft were extremely rare at first, as demonstrated by the "big sky" theory,[4] commercial aviation forced airways and air traffic control facilities to develop in order to keep pace with the increased activity. Accidents such as the 1956 mid-air collision between United Airlines and Trans World Airlines passenger airliners in uncontrolled airspace (resulting in 128 fatalities)[5] made evident the potential danger to the public and to aviation as a whole. Incidents such as the January 2007 Chinese ASAT test[6] or the February 2009 collision between the commercial Iridium and Russian Cosmos communications satellites[7] have had a similar impact on spacefaring nations, highlighting the need to consider how best to conduct safe and responsible operations in space and to promote those practices internationally. This realization is in addition to the fact that space debris accumulate and increasingly endanger the conduct of space activities in the Earth's orbits. These "*man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional*"[8] constitute a problem because of their high velocity (7500 m/s or much higher). They can pose a threat to functional space objects and, although it is relatively rare, even to structures or people on the ground when they de-orbit if they are large enough or contain hazardous materials,[9] such as radioactive substances.

Unregulated space activities could indeed have dire consequences on humanity's ability to travel through space. The absence of a regulatory framework could lead to an exponential increase in the number of collisions between (potentially manned) space objects, resulting not only in the loss of materials and human lives, but reduce access to the space domain as well. Furthermore, the number of dangerous space debris present in Earth's orbit has drastically increased since the beginnings of space exploration, reaching the hundreds of thousands. These may not only cause malfunctions, sometimes beyond repair, on our satellite constellations, but also pose the threat of triggering the "Kessler syndrome". Also called the Kessler effect, collisional cascading or ablation cascade, this theory was proposed by the NASA scientist Donald J. Kessler in 1978. It is a scenario in which the density of objects in LEO is so high that collisions between objects could cause a cascade where each collision generates space debris that increases the likelihood of further collisions.[10] One

[4] In aviation, the idea is that two randomly flying bodies are very unlikely to collide, as the three-dimensional space is so large relative to the bodies.

[5] Lt. Col. S. Hunter, *op. cit.*, note 2, p. 5.

[6] T. S. Kelso, "Analysis of the 2007 Chinese ASAT Test and the Impact of its Debris on the Space Environment", *AMOS Conference*, 2007, 10 p. URL: https://www.celestrak.com/publications/AMOS/2007/AMOS-2007.pdf.

[7] Lt. Col. S. Hunter , *op. cit.*, note 2, p. 5.

[8] Technical Report on space debris, United Nations General Assembly. Technical report of the Scientific and Technical Subcommittee on space debris. UN Doc. A/AC.105/720, 1999.

[9] https://en.wikipedia.org/wiki/Space_debris#To_Earth.

[10] Donald J. *Kessler* and Burton G. *Cour-Palais*, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt", Journal of Geophysical Research, 1978, 83, pp. 2637–2646.

implication is that the distribution of debris in orbit could render space activities and the use of satellites in specific orbital ranges infeasible for many generations. The resultant effects on world economies, information systems, and national security systems, are now fully acknowledged by spacefaring nations.

Space traffic management and space debris removal are not dealt with in the present body of space law and are thus left to either separate international agreements or to national laws and policies for two reasons. First, there is neither a dedicated international organization, nor a trade association, responsible for the creation, and perhaps implementation, of an international space code of conduct. Second, as national space launches mostly do not involve entry into foreign airspace, spacefaring nations usually apply their own national safety regulations to their governmental and/or private launch activities. This phenomenon can be assimilated into the "tragedy of the commons" theory,[11] as the benefits of individual space missions accrue primarily to the entities conducting these activities while the detrimental impact of space exploitation can have negative consequences for all those involved in the sector and even others. As a consequence, regulations adopted by a single or multiple states to fight off the harmful environmental effects of space activities would be ineffective. Spacefaring nations adhering to debris mitigation requirements may find themselves at a competitive disadvantage against those who do not observe similar measures.

On the international scale, the U.N. space treaties do not address the issue of space debris, mostly because there was no issue at the time the treaties were adopted. Actual international dialogue concerning the regulation of space debris started in the early 1980s, and the Inter-Agency Space Debris Coordination Committee (IADC) was established in 1993 upon the initiative of the world's major space agencies. After several years, the IADC developed space debris mitigation guidelines in 2002, which served as the basis for the space debris mitigation guidelines developed and adopted by UNCOPUOS in 2009.[12] A few other non-binding documents concerning such matters have also been issued, including the International Academy of Astronautics (IAA) Cosmic Study on Space Traffic Management of 2006,[13] and The Hague Code of Conduct against Ballistic Missile Proliferation of 2002,[14] but today a more radical approach seems necessary.

These guidelines are indeed not legally binding under international law and work only on a voluntary basis. Still, most national space agencies have been implementing the guidelines for years. Moreover, several states have included provisions on space debris mitigation and prevention in their national space legislation, such as

[11] Hardin Garrett, "The Tragedy of the Commons", in *Science*, Vol. 162, n° 3859, 13 December 1968, pp. 1243–1248.

[12] Uncopuos, *Space Debris Mitigation Guidelines*, United Nations Office for Outer Space Affairs, 2010, http://www.unoosa.org/pdf/bst/COPUOS_SPACE_DEBRIS_MITIGATION_GUIDELINES.pdf.

[13] IAA, *Cosmic Study on Space Traffic Management*, 2006, 96 p. URL: https://iaaweb.org/iaa/Studies/spacetraffic.pdf.

[14] UN, *Hague Code of Conduct against Ballistic Missile Proliferation*, General Assembly, 2002, URL: http://www.hcoc.at/documents/Hague-Code-of-Conduct-A_57_724-English.pdf.

the US Debris Mitigation Standard Practices,[15] based on the NASA Safety Standard, developed by NASA and the Department of Defense. These standard practices have four objectives: control of debris release during normal operations; minimization of debris generated by accidental explosions; choice of safe flight profile and operational configuration; post-mission disposal of space objects, either by re- or de-orbiting. The European Union Draft Code of Conduct for Outer Space Activities,[16] which was published by the EU in 2008 with a revised draft released in September 2010, is an instrument intended to be applicable to the space activities of the subscribing states and nongovernmental entities under their jurisdiction. It also addresses the issue of space debris and contains several measures aiming to prevent, reduce and mitigate the creation of space debris. While these various national regulations have helped to improve the mitigation of space debris, they might not constitute an optimal solution in the long run.

The need for the coordination of these activities, the harmonization of national rules and policies, as well as the development of a space debris clean-up plan by the international community has recently been emphasized by the aforementioned incidents as well as several scientific studies.[17] This might represent the only viable solution to ensure that all actors of the space sector, governments and private entities alike, act in such a way as to ensure the protection of the space environment as well as the safety of space objects. But it would be necessary to demonstrate the existence of an international obligation to cooperate, in order to force nations of the world to protect a limited natural resource and mankind's access point to outer space.

1.3 An International Obligation to Cooperate for the Benefit of Mankind

The importance of cooperation has often been pointed out, especially after the cold war, as a necessity to ensure the rule of law, including relevant norms of space law that play a prominent role in international cooperation for the exploration and use of outer space for peaceful purposes. In 1994, the UNGA emphasized the general interest of this principle in inviting states that were not yet parties to the Outer Space

[15] US Government, *Orbital Debris Mitigation Standard Practices*, December 2000, URL: https://orbitaldebris.jsc.nasa.gov/library/usg_od_standard_practices.pdf.

[16] *DRAFT International Code of Conduct for Outer Space Activities*, European Union (September 16, 2013). URL: http://www.consilium.europa.eu/uedocs/cmsUpload/st14455.en10.pdf.

[17] National Research Council. Orbital Debris: A Technical Assessment, 1995, 224 p.; Scientific and Technical subcommittee of the UNCOPUOS. *Technical Report on Space Debris*. United Nations, New York, 1999; National Research Council. *Limiting Future Collision Risk to Spacecraft: An Assessment of NASA's Meteoroid and Orbital Debris Programs*. Washington, DC: The National Academies Press, 2011.

Treaty to consider ratifying or adhering to it.[18] It was only in 1996 that a more general statement[19] was specifically dedicated to international cooperation for space activities, repeating the provisions of the previous texts, but emphasizing the need to take into account the needs of developing countries. If this resolution had a commendable objective, it is regrettable that its provisions are, for the majority, non-binding, and are in fact only suggestions, leaving states free to follow them or not. There are however several principles in the *corpus spatialis*, as well as other branches of international law, that could be used as a basis for the existence of an international obligation to cooperate for the benefit of mankind. These various dispositions stem not only from international space law, but from telecommunications and environment policies as well.

First, it is necessary to address the principles of space law that could constitute the basis for an international obligation to cooperate. As such, the "Common Interest" principle is particularly interesting. This principle appeared very early during the first space race through three resolutions of the UN's General Assembly,[20] and was then consecrated in the Outer Space Treaty of 1967 by both articles I et IX.[21] Two main rules result from these different texts: first, the exploration and use of outer space should be carried out for the benefit and in the interest of all countries, and second, that it should be carried out in due regard of the corresponding interests of all states parties to the Treaty.[22]

However, the scope of this "Common Interest" principle is still the object of controversies, especially concerning the word "countries", which has no legal consistency. The United States government, in particular, objected that while Article I "*would serve as a guide for space powers in developing their programs and conducting their activities in space […] it does not undertake to set any terms and conditions on which international cooperation would take place*".[23] Furthermore, the U.S. Department of State added that considering the vague formulation of Article I, it carries no legal obligation and is therefore not self-executing, a claim that has been supported by several authors.[24] Others however, consider that the use of the word "shall" in the wording of Article I reveals the intention the parties had to give this disposition a binding value.[25] In any case, the "Common Interest" prin-

[18] UNGA, *International cooperation in the peaceful uses of outer space*, A/RES/48/39, 10 December 1993.

[19] UNGA, *Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries*, A/RES/51/122, 4 February 1997.

[20] UNGA Res. 1348 (XIII) 15 December 1958; UNGA Res. 1472 (XIV) 12 December 1959; UNGA Res. 1721 (XVI) 20 December 1961.

[21] *Op. cit.*, note 3, Articles I & IX.

[22] M. Couston, *Droit spatial*, Ellipses, Paris, 2014, p. 103.

[23] UN doc A/AC.105/85, Annex 1, p. 9, 3 July 1970.

[24] S. Gorove, "Interpretations of international space law for private enterprise", *ADAS*, 1982, p. 319.

[25] L. Peyrefitte, *Droit de l'espace*, Précis Dalloz, Paris, 1993, p. 59.

ciple entails significant practical measures, such as mutual assistance, and some[26] consider that it could constitute the basis for an international public service, as defined by Charles Chaumont.[27] All in all, the "Common Interest" principle does not seem to be self-executing in and of itself. However, it can be conceived that it could form the basis of an international obligation to cooperate for active debris removal, just as it was used to found the creation of UNCOPUOS in 1958.[28]

Secondly, it should be noted that the Earth's orbits are subject to specific rules, not only thanks to the current international body of space law, but to the rest of international law as well. Article III of the Outer Space Treaty indeed stipulates that states parties shall carry on their space activities in accordance with international law.[29] This formulation, while seemingly obvious, objectively determines the outlines of certain concepts and other principles. It also means that while states parties must abide by space law, they are not exempt from other principles of international law simply because their activities happen in outer space. Indeed, several provisions of international law should be mentioned for their potential applicability to Active Debris Removal. For example, Article 33§2 of the ITU convention of Malaga Torremolinos—which most closely concerns the management of Earth's orbits—highlights the fact that "*radio frequencies and the geostationary satellite orbit are limited natural resources*" and that they must be used "*efficiently and economically*".[30] This article is the basis for the ITU's Orbit/Spectrum Allocation Procedure, ensuring an equitable allotment of limited natural resources to all nations. But considering the essential nature of geostationary orbits for all kinds of telecommunications in contemporary society, it seems crucial not only to use them in an efficient manner but also to ensure the sustainable development of these orbits for the future. Arguably, mitigating the effects of the tragedy of the commons,[31] and preventing a catastrophic implementation of the Kessler syndrome, fits well within such a goal. Thus it seems logical to consider that member states of the ITU should be legally bound to not only reduce to a minimum their production of space debris, but to partake in active debris removal as well.

Finally, the UN space treaties have very little to say about pollution issues, and even the Moon Treaty, which is arguably the most advanced of these from an environmental standpoint, has gained no more than 15 states parties, which renders the instrument practically meaningless. It could be argued however that principles taken direct from international environmental law might be applied to the Earth's orbits as

[26] M. Couston, *op. cit.*, note 22, p. 105.

[27] C. Chaumont, "Perspectives d'une théorie du service public à l'usage du droit international contemporain", *in La technique et les principes du droit public. Études en l'honneur de Georges Scelle*, t. 1, Paris, LGDJ, 1950, pp. 115–178.

[28] UNGA, *Question of the peaceful use of outer space*, res 1348 (XIII), 13 December 1958.

[29] *Op. cit.*, note 3, Article III.

[30] *International Telecommunications Convention*, 25 October 1973, (entered into force on 1 January 1975), Malaga Torremolinos, Art. 33. URL: http://search.itu.int/history/HistoryDigitalCollectionDocLibrary/5.10.61.en.100.pdf.

[31] Lotta Viikari, "Environmental aspects of space activities", *Handbook of Space Law*, Frans Von Der Dunk (dir.) with Fabio Tronchetti, Edward Elgar Publishing, 2015, 1100 p., p. 717.

the foundation of a joint task, and most precisely the principle of sustainable development. The concept was first introduced in 1987 in the Brundtland Commission's report "Our Common Future".[32] According to the definition given in that report, sustainable development is development that "*meets the needs of the present generation without compromising the ability of future generations to meet their own needs*". The Stockholm Declaration of 1972[33] frequently referred to sustainable development, and two decades later the 1992 Rio Declaration on Environment and Development[34] set out the concept in more detail. Though it had no binding effect on its own, the principle of sustainable development has since attained widespread endorsement and has been incorporated in various other international instruments as well as legally binding treaties.

It could also be argued that obligations of international environmental law may have an *erga omnes* value, especially those pertaining to the protection of the global environment, as was addressed by the ICJ in the 1974 *Nuclear Tests* cases.[35] The principle of sustainable development was even directly referred to by the ICJ in the *Gabcikovo-Nagymaros* case of 1997.[36] In this last case, Hungary tried to have an *erga omnes* value applied to the precautionary principle in order to invalidate a 1977 Treaty concluded with Slovakia, an argument that was later rejected by the court. It can be concluded that, currently, there is no international obligation that development be sustainable, especially in space law, although it has been argued that protection of the space environment is an obligation *erga omnes*.[37] It could however easily acquire a binding value if integrated in the *corpus spatialis*, thus founding an international obligation to cooperate for active debris removal.

While none of the aforementioned principles drawn from the different bodies of international law could on their own form the legal basis to set up a joint task of Active Debris Removal with the objective of ensuring the safety of Earth's orbits and the sustainable development of Mankind's space activities—or at the very least justify the adoption of a legally binding document—a combination of these might be able to. Indeed, it seems today that the adoption of an international agreement is the only viable option to ensure safety for future space activities. Such a document would not only need to increase the level of cooperation between states, but also devise a way to efficiently manage space debris removal. The adoption of a legally binding treaty thus seems unavoidable.

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[32] World Commission on Environment and Development.

[33] UNGA, *United Nations Conference on the Human Environment*, 15 December 1972, A/RES/2994, available at: http://www.refworld.org/docid/3b00f1c840.html [accessed 12 November 2017].

[34] UNGA, *Rio Declaration on Environment and Development*, 12 August 1992, A/CONF.151/26 (Vol. I).

[35] Lotta Viikari, *The environmental element in Space Law: assessing the present and charting the future*, Martinus Nijhoff Publishers, Leiden, 2008, p. 140.

[36] *Gabcikovo-Nagymaros Project*, (Hungary/Slovakia), Judgment, ICJ Reports 1997, p. 7.

[37] Lotta Viikari, *op. cit.*, note 35, p. 149.

1.4 The Implementation of a Specialized International Treaty

The issues of contemporary space activities mainly focus on the establishment of the sustainable development of human activities in a precious environment. As previously said, a few key items have already been the subject of several attempts to formulate rules of different form, including a variety of recommendations, charters, guidelines, and codes of conduct, but could benefit from being integrated into a more compelling international regime. As such, it would seem relevant to make all the aforementioned soft law into a comprehensive and binding treaty. This regime, adopted on the basis of the existence of an international obligation to cooperate in order to ensure the sustainable development of outer space activities, would need to deal with the following issues.

First, it seems imperative to resolve the matter of the absence of a clear definition of "*space debris*". Current international law states that *"[t] he term of 'space object' includes component parts of a space object as well as its launch vehicle and parts thereof*".[38] It should be noted that these space objects are the only subjects of the Liability Convention and Registration Convention, as well as Article VII (state liability for damage) and VIII (registration of space objects) of the Outer Space Treaty, while Article VI of the Outer Space Treaty only regulates "*activities in outer space*".[39] Therefore, it is reasonable to assume that the subject matter designated as "space object" is a dedicated description for the purposes of the Liability and Registration Conventions, that is to say only a part of the body of international space law.[40] While satellites, launch vehicles, and trans-orbital vehicles (including rovers), obviously fall into the aforementioned definition, space debris are far more ambiguous. The fact that they are neither registered nor registrable, and that they are out of any sort of control, makes it that much harder for a state to apply the liability regime in order to receive damages.

Lucien Rapp identifies several major difficulties with the application of the standard liability regime to space debris.[41] First, assimilating 'space debris' into the term 'space object' would seem to be a far too extensive interpretation of existing space law, especially considering both the nature and number of these debris. Additionally, Rapp points out the difficulty of proving a causal link between damage suffered by a standard space object and debris in orbit, as well as the question of the identification of a liable state. And lastly, the absence of any mandatory inter-

[38] *Convention on International Liability for Damage Caused by Space Objects,* 29 March 1972, 961 UNTS 187; 24 UST 2389; 10 ILM 965 (1971) (entered into force 1 September 1972), art 1(d), URL: http://www.unoosa.org/pdf/gares/ARES_26_2777E.pdf; *Convention on Registration of Objects Launched into Outer Space*, 6 June 1975, 28 UST 695, 1023 UNTS 15 (entered into force 15 September 1976), art 1(b), URL: http://www.unoosa.org/pdf/gares/ARES_29_3235E.pdf.

[39] *Op. cit.*, note 3, Articles VI, VII & VIII.

[40] Yu Takeuchi, *Legal aspects of international regime for space traffic management*, Institute of Air and Space Law, Faculty of Law, McGill University, 2014, 100p., p. 59.

[41] Lucien Rapp, "Repenser le contentieux relatif aux débris spatiaux", in Laurence Ravillon, *Le règlement des différends dans l'industrie spatiale*, LexisNexis, 2016, p. 251.

national standard, from which it would be possible to assess the behaviour of the state concerned and determine whether or not this behaviour is at fault, makes it nearly impossible to deal with space debris in the same way as a regular space object. This further highlights the need for an update of international space law.

Second, some authors[42] have suggested that an ADR regime should be modelled on the 2007 Nairobi International Convention on the Removal of Wrecks.[43] This specific regime is based on three principles: the liability of the wreck's owner for the costs of locating, signalling and removing said wreck; the requirement for insurance to compensate for a possible failing of the owner, with verification by the state of registration; and the right of the state to take direct action against the insurer or any other person from whom the financial guarantee covers the liability of the owner. This regime would certainly have to be adapted to the specificity of active debris removal, mainly for two reasons[44]: wrecks—contrary to most space debris—may still have commercial value, and they are notably easier to remove. According to Rapp, the solution might lie in the fostering of commercial interests and the advent of space debris removal as a lucrative activity. It has also been suggested by some[45] to simply create a commercial activity equivalent to that of the removal of wrecks. Rapp adds that such an activity could be financed by an international fund financed by launching states and operators, in a "*Pay or Play*" fashion akin to electronic communications.[46] He then suggests that the future multiplication of space debris-related disputes would most probably be met with two answers.[47] The first possibility is that these disputes, based on national policies, would be dealt with by national jurisdictions, which eliminates the need for an intervention by the international community. The second possibility, inspired by three Japanese authors,[48] is to substitute a liability for fault with a *liability of each operator for a defective product*. The failure of the operator to fulfil its obligation of removal would then be construed as a defect of the product itself.

Finally, a dedicated international treaty would need to address the gaps in the state responsibility and liability regime for damages caused by space activities. The current liability system of international space law establishes fault-based liability for in-orbit damages and absolute liability for ground damages.[49] But both provi-

[42] *Ibid.*, pp. 258–261.

[43] *International Convention on the Removal of Wrecks*, Nairobi, 18 May 2007 (entry into force 14 April 2015). URL: http://www.bahamasmaritime.com/wp-content/uploads/2015/12/Nairobi-International-Convention-on-the-Removal-of-Wrecks-2007.pdf.

[44] Lucien Rapp, *op. cit.*, note 41, p. 259.

[45] W. Munters and J. Wouters, "The road not yet taken for defusing potential conflicts in Active Debris Removal: a Multilateral Organization", *4th Manfred Lachs International Conference on Conflicts in Space and the Rule of Law,* 27–28 May 2016.

[46] Lucien Rapp, *op. cit.*, note 41, p. 260.

[47] *Ibid.*, pp. 262–263.

[48] S. Kozuka, M. Uchitomi and H. Kishindo, "The international regime for space debris remediation in light of commercialized of space activities", *Proceeding IISL*, 2013.

[49] *Convention on International Liability for Damage Caused by Space Objects,* 29 March 1972,

sions leave gaps in regard to contemporary space activities. First, the gap between the state exercising jurisdiction and control over a space activity (or "State of registry"), as per Article VIII of the Outer Space Treaty, and the state authorizing and supervising the activity, as per Article VI of said Treaty. For example, if a private company in state A were to contract with a launch operator from state B to launch a space object, state A would normally consult with state B regarding the object's registration in accordance with Article II.2 of the Registration Convention.[50] However, a problem could occur if state B were to transfer the satellite's operation to a third state (state C) after having operated it for a certain amount of time. Since the "State of registry" is assumed to be the launching state,[51] how can state C exercise its jurisdiction and control over the satellite?

The problem with the concept of "launching state" is that the liability regime of the UN space treaties does not seem to consider that the operation of a spacecraft could be conducted by a different state. This discrepancy between the role of a launching state and an "operating State", as well as generally insufficient coordination among launching states, highlights the need to entrust certain responsibilities to the appropriate states.[52] As for in-orbit damages, as the case of Cosmos-Iridium pointed out, identifying the liable state is relatively difficult because of the laboriousness of collecting objective data on the circumstances of the collision. The implementation of an SSA data sharing regime, part of a future treaty, could help determine liability more easily.

Finally, concerning ground damages, the Liability Convention of 1971 doesn't address the potential risk of damaging daily activities on the ground as—sometimes critical—systems malfunction might occur due to in-orbit collision. Should ground damages be considered fault liability, or should in-orbit damages be considered the sole liability? The lack of major accidents involving third party damages on the ground has kept this issue from being resolved by the international community, but the question calls for an answer. An international treaty could clarify the situation as well as the responsibility and liability regime that weighs or does not weigh on states for debris-related damages.

It seems that most issues that contemporary space activities suffer from could be resolved by the adoption of an international regime focused on the management of orbit pollution and space debris. Not only would it help to develop international cooperation regarding the exchange of information and data on Space Situational Awareness, but also on space debris mitigation and removal as well, allowing for safer orbits for all space activities and actors. Moreover, developing the liability system of the UN space treaties to incorporate Space Traffic Management would

961 UNTS 187; 24 UST 2389; 10 ILM 965 (1971) (entered into force 1 September 1972). URL: http://www.unoosa.org/pdf/gares/ARES_26_2777E.pdf.

[50] *Convention on Registration of Objects Launched into Outer Space*, 6 June 1975, 28 UST 695, 1023 UNTS 15 (entry into force 15 September 1976). URL: http://www.unoosa.org/pdf/gares/ARES_29_3235E.pdf.

[51] *Ibid.*, Art. I.

[52] Yu Takeuchi, *op. cit.*, note 40, p. 68.

enable states to conduct their space operations without fear of not being compensated for potential damages. Such a treaty would make outer space safe enough to sustain the further development of space activities.

1.5 The Creation of a Dedicated International Organization

But, is an international treaty sufficient to ensure that these requirements are met with? Could a dedicated international organization be created with the purpose of implementing the principles of such a treaty? Should it be? The idea here would be to establish an inter-governmental organization based on the early INTELSAT model to foster the development of the technology(ies) for active debris removal and on-orbit satellite servicing, and subsequently to perform removal and servicing operations on a commercial basis. Such an organization could not only act as a clearinghouse charged with collecting and redistributing SSA information and data, but could actively coordinate the launches of space objects around the world, as well as the management of space debris in orbit, in order to avoid collisions and maintain control over the re-orbiting or de-orbiting of said debris. If appropriate, it could also settle disputes between states according to new rules of responsibility and liability and, ultimately, enact regulations relevant to its domain of competence.

The first issue to address is the need for a comprehensive Space Situational Awareness Information and Data Sharing legal framework, in order to settle political challenges and assure the effective and transparent provision of unified SSA information and data to spacecraft and space object operators on a global scale. To accomplish that, it seems crucial to consider the establishment of an international clearinghouse for data and information sharing, based on Article X of the Outer Space Treaty of 1967, which promotes international cooperation by asking states parties to consider requests to observe space objects launched by other states parties. The Space Data Association Limited (SDA), which was founded by the three major worldwide satellite operators (Inmarsat, Intelsat and SES), could be used as a model for such a clearinghouse, since the necessity of this type of structure is widely recognized by both commercial and civil governmental operators. While in Air Traffic Management the provision of services from states is achieved by dividing airspace into multiple flight information regions (FIR), the nature of space activities does not allow for the same system. Indeed, satellites in LEO can go around the Earth in about ninety minutes, passing over a country in a few seconds. Using a similar technique as flight information regions for STM would not be realistic, especially since the concept implies the mutual recognition of every state having “com-

plete and exclusive sovereignty over the airspace above its territory",[53] which does not exist in international space law.[54]

Therefore, it seems more efficient to designate a clearinghouse as the central data provider for STM, instead of requiring each state to directly provide information for its own space operations.[55] This Data Sharing Center[56] would be charged with gathering observation and operation data from SSA entities and operators in order to then provide the information necessary for space activities to the operators concerned with space traffic. This clearinghouse could also delete, or anonymise sensitive information and data (for example relative to matters of national security) upon request from data providers. For now, only the respective militaries of the U.S. and Russia can provide comprehensive information and data for SSA, but the limited ability of other states (such as Australia, China, France, Germany or Japan) could still be used to increase data accuracy. Data provision from concerned states could be on a voluntary basis at first, but eventually it would have to become a legal obligation in order to achieve constant data gathering on an equal basis among all space-faring nations. A new international treaty would be needed to impose such obligations on states.

Second, after setting up a regime imposing obligations on states parties, it would be needed to create a dispute settlement organism charged with dealing with matters of responsibility and liability according to the updated *Corpus spatialis*. The creation of a supranational judicial body on the basis of a legal *corpus*, which can be very limited (such as the international body of space law), is likely to produce an efficient legal system.[57] It is no longer possible to ignore the fact that new sources of law have emerged,[58] beyond the usual procedure of international negotiation between governments. In the specific context of space law, it can also be noted that no international jurisdiction except the International Court of Justice (ICJ) is competent to settle space-related disputes. The creation of a specialized supranational judicial body could then be a sufficiently flexible method of creating standards to accommodate the evolution of space technologies and activities. Such a judicial body could be chaired by specialized judges, but also allow non-states parties, such

[53] *Convention on International Civil Aviation,* 7 December 1944, 15 UNTS 295, ICAO Doc 7300/6 (entered into force 4 April 1947), Art. 1, URL: http://www.icao.int/publications/Documents/7300_orig.pdf.

[54] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, 27 January 1967, 610 UNTS 205, 18 UST 2410, TIAS No 6347, 6 ILM 386 (entered into force on 10 October 1967), rt. 2, URL: http://www.unoosa.org/pdf/gares/ARES_21_2222E.pdf.

[55] Yu Takeuchi, *op. cit.*, note 40, pp. 52–53.

[56] *Ibidem*.

[57] Marie-Anne Frison-Roche, "Le droit, source et forme de régulation mondiale", in Jacquet Pierre, Pisani-Ferry Jean, Tubiana Laurence (eds), *Gouvernance mondiale*, (Rapport du conseil d'Analyse économique n°37, La documentation française, 2010) p. 313.

[58] For example, the creation of private international law at the initiative of enterprises, and the intensification of the production of public international law following the establishment of the World Trade Organisation's (WTO) Dispute Settlement Body (DSB).

as private firms, to make their cases before the court. Moreover, the creation of such a judicial body could become a necessity considering that the increase in space activities will most certainly be accompanied by an increase in the number of disputes. However, the ICJ is not equipped to deal with a potentially huge number of cases. The creation of a space-related judicial body, if not only a space debris-related court, would allow for more efficient management of litigation and for the increase of the body of space law through jurisprudence.

The idea of a World Space Organization was proposed for the first time in 1968 in Vienna at UNISPACE-I, and then finally postponed in 1982 (UNISPACE-II). The subject appeared again in 1999 during UNISPACE-III, when the representative of the Greek delegation, M. Vasily Cassapoglou, raised the fact that space activities and space exploration were increasingly escaping from effective control by international institutions, and that one could almost call this "*new global neo-colonialism*".[59] Ms. Simone Courteix was a supporter of the creation of a WSO[60] in the creation of which states would participate and under which they would continue to work together to establish long term goals. The CERDE has already identified several areas and themes that might require the creation of such an organization, including the implementation of programs of launch services that could benefit developing countries (transfer of technology, creation of spatial data bank or specialized staff training), as well as the coordination and control of the growing and sometimes alarming number of objects launched into space.[61]

Furthermore, as part of the development of the exploitation of resources in outer space, project OASIS[62] has developed the idea of a spaceport network infrastructure enabling, in the long term, the exploitation of resources on Mars. The first step of the project would be to build a "node" in LEO, capable of offering in-orbit services (refuelling, reparation, etc.) that would work under the authority of an International Spaceport Authority (ISPA) and offer services *via* a Spaceport Company (SCP). The ISPA would be created through a public-private partnership (PPP), following the example of Arianespace, and the SCP would have member states as shareholders.[63] Such an Authority could be able to fulfil the role of the aforementioned WSO. However, the idea of creating this ISPA through a PPP could be problematic: while the example of Arianespace offers some hope, it should be recalled that the European Union failed to finance the GALILEO GNSS program through a private-

[59] Juan Manuel de Farimiñan Gilbert et Claudio Zanghi, "L'organisation mondial de l'Espace, un défi oublié?", in Armel KERREST, *L'adaptation du droit de l'espace à ses nouveaux défis*, A. Pedone, 2007, 318 p.

[60] *Ibidem*.

[61] *Ibidem*.

[62] Clegg et al., ISU Team OASIS (September 2012) *Operations and Service Infrastructure for Space. Team Project: Spaceports,* Final Report Edition, SSPI2, Strasbourg, France, International Space University (ISU), 105 pages.

[63] Mueller et al., "Effective Utilization of Resources and Infrastructure for a Spaceport Network Architecture", American Institute of Aeronautics and Astronautics, 2012, 26 p., p. 15. URL: https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20120003443.pdf..

public partnership, and was even slowed down by the subsequent disagreements that sprung from the discussions.[64]

The creation of such an organization would encounter some difficulties as, of course, such programs are generally established by individual states, and that such activities can concern important economic and industrial interests, but also national security, etc. All these considerations explain the reluctance so far of states to participate in large-scale cooperation in this area, and the preference for international agreements of limited scope. For all these reasons, it now seems important to focus on contemporary and future forms of cooperation in space and their influence on space Law, both domestic and international.

1.6 Conclusion

To conclude this paper, it should be reminded that the *Corpus spatialis* established by the UN space treaties holds some *lacunae* of law. While various new issues did not exist at the time of negotiation of these treaties, the recent development of telecommunications and the promise of new prospects for the exploration and exploitation of outer space (space tourism, deep space mining, etc.) reveal the gaps left by States during the first Space Race and the need for an update of international space law. The subsequent increase of both space traffic and the number of space debris therefore has to be dealt with in an efficient manner, preferably with the participation of all space-faring nations as the existence of an international obligation to cooperate has previously been proven. The development of national regulations hold out until now and will probably still hold for at least a few years on specific issues, but an international treaty would be ideal to deal with other issues that can't be settled by individual States such as the need to ensure the sustainability of Earth's orbits and to make outer space in general a safer environment to conduct operations.

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[64] Martin Caudron, "Galileo : Le Partenariat Public-Privé à l'Épreuve du Juste Retour", *Bruges Political Research Papers/Cahiers de recherche politique de Bruges*, No 11/février 2010.

Chapter 2
Dispute Resolution in the Context of ADR: A Public International Law Perspective

Valentina Nardone

Abstract Bearing in mind that there are currently no dedicated instruments dealing with dispute settlement in the area of ADR, States and/or private entities can resort to other available dispute settlement mechanisms in international law, such as diplomatic means or adjudicative methods. After an examination of the pros and cons of existent mechanisms, this paper will advocate the creation of a specialized International Governmental Organization tasked with the development and operation of active debris removal technology and equipped with a specialized body or tribunal with compulsory jurisdiction over ADR related disputes.

2.1 Introduction

Active Debris Removal (hereinafter, ADR) is one of the commonly known regimes proposed to start cleaning-up outer space, by targeting debris already orbiting around the Earth. In addition to mitigation efforts, which address, conversely, the rate of the creation of new pieces of space debris, ADR projects are currently being elaborated by space agencies around the world in order to undertake the precautionary action against the potential catastrophic consequences that collisions between a space object and space debris could generate in outer space and on Earth alike.[1] In this sense, ADR strategies are a significant tool to ensure outer space security, safety and sustainability.[2]

[1] For a technical discussion on the application of the precautionary principle to the outer space environment, see O. de Oliveira Bittencourt Neto, Preserving the Outer Space Environment: The "Precautionary Principle" Approach to Space Debris, in Proceedings of the International Institute of Space Law, The Hague, 2013, p. 341 ss.

[2] For a further analysis about space sustainability, see R. A. Williamson, Assuring the sustainability of space activities, in Space policy, 2012, p. 154 ss.

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More precisely, based on a new concept of environmental protection, ADR strategies address outer space sustainability in more than one way. First, in the short term, the gradual elimination of dangerous debris in orbit enhances the confidence of satellite operators that the services they offer will be secure from interruption or malfunction; second, in the long term, it helps safeguard outer space availability for future generations, assuring its effective sustainable use.

Far from being a purely technical matter, ADR entails economic, policy and legal concerns, thus necessitating a multidisciplinary approach. Here, the legal question of dispute resolution will be addressed. As ADR is a very dangerous and complex activity, differences of opinion among involved actors can easily arise, including both States and private entities. In fact, along with public bodies, such as space agencies and governments, private entities can also be involved in this brand-new activity, which is considered an attractive business opportunity. For this reason, in particular, it is important to understand the current dispute settlement mechanisms that are available for disputes over ADR matters, and to assess their accessibility and efficiency.

Moreover, such mechanisms are of the utmost importance as their presence contributes to the establishment of a clearer framework that is easy to resort to in case of necessity, thus minimizing the risk of countermeasures that could be very dangerous, given the main characteristics of the space domain. In this sense, and as an integral part of ADR strategies, dispute settlement mechanisms can be seen, *mutatis mutandis*, as another means of ensuring the security, safety and sustainability of outer space activities.

Given the international character of the area in which ADR actions would take place, as well as the potential multinationalism of the actors involved, the most appropriate perspective to be assumed is the international law perspective. Before drawing some conclusions on dispute settlement characteristics in the context of ADR, and in the light of the lack of dedicated instruments, the following pages will assess the suitability of current mechanisms of dispute settlement in international (space) law, highlighting some critical points; then, building on the proposal to establish a specialized ADR International Governmental Organization (hereinafter, IGO),[3] it will be argued that it will eventually need to be equipped with specific competences on compulsory dispute settlement.

[3] This idea has been recently proposed in this contribution: W. Munters, J. Wouters, The road not yet taken for defusing conflicts in active debris removal: a multilateral organization, Working Paper n°183, May 2017, available at https://ghum.kuleuven.be/ggs/publications/working_papers/2017/wp183munters.pdf (23.11.17).

2.2 Current Mechanisms and Their Accessibility

Before going into detail, it should be clarified that the analysis here proposed focuses mainly on the accessibility of the mechanisms concerned. In other words, current dispute settlement means in international (space) law are classified on the basis of their personal scope, i.e. whether they are accessible only by States or also by private entities.

2.2.1 Inter-States Litigation

As it is well known, space law has thus far paid little to no attention to dispute settlement. Among the five international treaties establishing a binding legal framework concerning the exploration and use of outer space for peaceful purposes,[4] only one contains explicit procedural provisions on compensation for damage caused by space objects in outer space as well as on Earth. In fact, the 1972 Liability Convention provides for the possibility of setting up a body (a "Claim Commission") when a dispute fails to be settled through direct negotiations. However, even if this provision is a significant step forward, its potential weight is undermined by the fact that a Claim Commission's decisions have a recommendatory nature, i.e. they are not binding on the parties to a dispute concerning compensation.[5]

Setting aside liability issues, which not always at stake in a dispute concerning space activities in general, and potentially ADR in particular,[6] space treaties are not very helpful in defining the means for dispute settlement. However, the 1967 Outer Space Treaty (hereinafter, OST) contains a very important disposition that deals with the applicability of international law and the Charter of the United Nations to the outer space domain. Apart from Article I.2, that also deals with international law,[7] Article III of the OST reads as follows:

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[4] Treaty on Principles governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, 610 UNTS 205 (1967) (Outer Space Treaty); Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, 672 UNTS 119 (1968); Convention on International Liability for Damage Caused by Space Objects, 961 UNTS 187 (1971); Convention on Registration of Objects Launched into Outer Space, 1023 UNTS 15 (1975); Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 1363 UNTS 3 (1979).

[5] For a more detailed overview of dispute settlement means in space law, see M. Williams, Dispute resolution regarding space activities, in F. Von Der Dunk, F. Tronchetti (eds.), Handbook of space law, Cheltenham, 2015, p. 995 ss.

[6] For further information about liability for space debris, see H. Kazemi, A. A. Golroo, H. Mahmoudi, Liability for Space Debris in the Framework of Private International Space Law, in Proceedings of the International Institute of Space Law, The Hague, 2013, p. 367 ss.

[7] Article I.2 of the OST reads as follow: "2. Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies".

> States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, *in accordance with international law, including the Charter of the United Nations*, in the interest of maintaining international peace and security and promoting international cooperation and understanding (emphasis added).

As has been acknowledged, this Article implies that the international law applicable to outer space includes "not only long-established rules of customary international law, such as the principles of good faith and of *pacta sunt servanda*, but also basic and explicit tenets of international law that have found their way into the UN Charter. Examples are the sovereign equality of States, non-intervention and […] *the peaceful settlement of international disputes* (emphasis added)".[8]

This finding is supported by two important considerations. On the one hand, space law is not a self-contained regime in international law.[9] On the other hand, recent initiatives aimed at facilitating transparency and confidence-building in outer space activities have recalled the importance of the principle of peaceful settlement of disputes: for example, point 12 of the Preamble of the (moribund?) *Draft International Code of Conduct for Outer Space Activities* promoted by the European Union calls on subscribing States to reaffirm "existing commitments to resolve any dispute concerning activities in outer space by peaceful means". After all, according to some prominent scholars, the obligation of peaceful settlement of international disputes has acquired the *status* of customary international law, being the natural consequence of the prohibition on the threat or use of force.[10]

In the light of the aforementioned considerations, it is evident that international rules on the peaceful settlement of disputes that are in force even in outer space, must also apply to disputes concerning ADR activities. More precisely, according to Article 33 of the UN Charter, States parties to a dispute concerning ADR activities

[8] O. Ribbelink, Article III of the Outer Space Treaty, in S. Hobe, B. Schmidt-Tedd, K.-U. Schrogl (eds.), Cologne Commentary on Space Law. Volume 1: Outer Space Treaty, Köln, 2009, p. 67. The same author talking specifically about the applicability of UN Charter underlines that "[i]t is undisputed that a very substantial part of the Charter of the United Nations is applicable to human activities in outer space. This includes […] obligations which can be found in Chapter VI, Articles 33–38, on 'Peaceful Settlement of Disputes' […]".

[9] The term "self-contained" entered the domain of international law thanks to the decision on the *S. S. Wimbledon* case (Case of the S.S "Wimbledon", (Brittany, France, Italy and Japan (with Poland as intervener) v. Germany) 17 August 1923, PCIJ) adopted by the *Permanent Court of International Justice* (PCIJ); the first case in which the entire locution "self-contained regime" was used is the *Teheran Hostages* case (Case concerning United States Diplomatic and Consular Staff in Tehran (United States of America v. Iran), 24 May 1980, ICJ) rendered by the *International Court of Justice* (ICJ). In this famous case the Court found that rules on diplomatic law constitute a self-contained regime provided with autonomy, not needing the help of the rules on State responsibility contained in the dedicated ILC Draft. However, the Court failed to define the main characteristics of such a regime, leaving on legal scholars the burden to answer the question. For an authoritative explanation of what a self-contained regime in international law is, see B. Simma, D. Pulkowski, Of Planets and the Universe: Self-contained Regimes in International Law, in European Journal of International Law, 2006, pp. 483–529.

[10] A. Cassese, Diritto internazionale, Bologna, 2006, p. 316 ss.

have the freedom to have recourse by mutual consent to two categories of mechanisms.[11]

On the one hand, States can resort to negotiation, enquiry, mediation, conciliation or good offices, which together are commonly referred to as diplomatic means of dispute settlement, involving only the parties to a dispute or even a neutral third party that helps them to ascertain the facts and/or to reach a solution. These means are non-binding in nature and they result in the adoption of non-compulsory proposals for the settlement of the dispute. Given the sensitive nature of information about space assets and satellites, States will be inclined to choose diplomatic means, probably negotiations, to be able to ensure the confidentiality of the information concerned. This is the method Russia and Canada decided to follow in the Kosmos 954 case.

Conversely, States are free to resort to adjudicative methods of dispute settlement, i.e. arbitration or judicial settlement. In this case, the third party involved would be an official arbitrator (or a panel of arbitrators) or a tribunal; at the same time, the solution adopted would be contained in an award binding upon the parties to the dispute.

As far as judicial means are concerned, we should not forget the significant role that the International Court of Justice (hereinafter, ICJ) could play in the interpretation of space law, reinforced by the possibility of creating *ad hoc* specialized chambers in order to treat particular or technical cases.[12] However, the potential function of the ICJ as a major center for dispute settlement in ADR related matters is undermined by two major factors. First, none of the space treaties inserted a jurisdictional clause on the compulsory jurisdiction of the ICJ stating that if parties disagree over the interpretation of application of them one may refer the dispute to it.[13] Second,

[11] For a complete overview of the international jurisprudence dealing with space-related matters, see M. Hofmann, Space Activities in the Jurisprudence of International Dispute Settlement Institutions, in Proceedings of the International Institute of Space Law, The Hague, 2014, p. 745 ss.

[12] Article 26 of the Statute of the ICJ reads as follows: "1. The Court may from time to time form one or more chambers, composed of three or more judges as the Court may determine, for dealing with particular categories of cases; for example, labor cases and cases relating to transit and communications. 2. The Court may at any time form a chamber for dealing with a particular case. The number of judges to constitute such a chamber shall be determined by the Court with the approval of the parties. 3. Cases shall be heard and determined by the chambers provided for in this article if the parties so request".

[13] Article 36 of the ICJ Statute: "1. The jurisdiction of the Court comprises all cases which the parties refer to it and all matters specially provided for in the Charter of the United Nations or in treaties and conventions in force. 2. The states parties to the present Statute may at any time declare that they recognize as compulsory ipso facto and without special agreement, in relation to any other state accepting the same obligation, the jurisdiction of the Court in all legal disputes concerning: the interpretation of a treaty; any question of international law; the existence of any fact which, if established, would constitute a breach of an international obligation; the nature or extent of the reparation to be made for the breach of an international obligation. 3. The declarations referred to above may be made unconditionally or on condition of reciprocity on the part of several or certain states, or for a certain time. 4. Such declarations shall be deposited with the Secretary-General of

none of the spacefaring nations have accepted the compulsory jurisdiction of the Court provided for in Article 36(2) of the ICJ Statute.[14] More generally, these features limit the potential role of the ICJ in space law as a whole.[15]

Different is the case of arbitration. Thanks to the adoption of the *2011 PCA Outer Space Rules,* matters can change significantly. However, given its importance for private entities participating in space activities, it will be discussed in the next paragraph.

2.2.2 The Position of Private Entities

The negative impact of the absence in international law of compulsory dispute settlement mechanisms specifically designed to deal with space activities is amplified by the fact that none of the means traditionally available in international law and adaptable to ADR disputes are accessible to private parties: *locus standi* before international courts is normally allowed only to subjects of international law, i.e. States and IGOs.[16] In fact, this "situation contributes to a climate of uncertainty potentially discouraging to private investors and companies interested in being involved in space activities".[17]

Moreover, due to the progressive commercialization of outer space activities, it is impossible to deny that private entities are now at the center of the space arena; this feature has rocked the paradigm of the State-centric regime on which the entire *corpus iuris spatialis internationalis* has been based so far, and advanced mechanisms of dispute settlement have proven to be necessary.[18]

As was anticipated, thanks to the adoption of the *Optional Rules for Arbitration of Disputes Relating to Outer Space Activities* (hereinafter, Outer Space Rules) made by the Administrative Council of the Permanent Court of Arbitration on the

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the United Nations, who shall transmit copies thereof to the parties to the Statute and to the Registrar of the Court. 5. Declarations made under Article 36 of the Statute of the Permanent Court of International Justice and which are still in force shall be deemed, as between the parties to the present Statute, to be acceptances of the compulsory jurisdiction of the International Court of Justice for the period which they still have to run and in accordance with their terms. 6. In the event of a dispute as to whether the Court has jurisdiction, the matter shall be settled by the decision of the Court".

[14] Cfr. *supra*.

[15] For a technical discussion, see G. M. Goh, Dispute Settlement in International Space Law. A Multi-Door Courthouse for Outer Space, Leiden-Boston, 2007, pp. 130–133.

[16] An important exception are human rights courts and tribunals.

[17] F. Tronchetti, Fundamentals of Space Law and Policy, New York Heidelberg Dordrecht London, 2013, p. 48.

[18] For a more detailed discussion on the involvement of private entities in space debris remediation, see S. Kozuka, M. Uchitomi, H. Kishindo, The International Regime for Space Debris Remediation in Light of Commercialized Space Activities, Proceedings of the International Institute of Space Law, The Hague, 2013, p. 395 ss.

6th December 2011, private entities now have the opportunity to access a means to solve disputes internationally.

After all, one of the main reasons on which the PCA based its decision to start a study on the feasibility of *ad hoc* rules for dispute settlement was exactly the lack of a valid means for settling disputes in the space sector, available to all the parties involved in space activities. As explained by the Advisory Group in charge of preparing the Report accompanying the adoption of the *Outer Space Rules*, a major *lacuna* of international space law was the gap between norms and the novel characteristics of the space sector, acquired in its evolution along three key standards: privatization, commercialization and internationalization. More precisely, the limited material and personal scope of existing rules and mechanisms of dispute settlement were described as the most important deficiency. Besides, years earlier the same shortage was highlighted by the *International Law Association* (hereinafter, ILA) that, between the 1980s and 1990s, tried to elaborate two draft conventions on dispute settlement in the space sector.[19]

Even if a complete examination of these rules goes beyond the scope of the present analysis,[20] it is however important to sum up their key points.

First, they are voluntary in nature: this means that the *Outer Space Rules* do not constitute a compulsory mechanism for dispute settlement, and parties to a dispute are free to refer, or not, the controversy to the PCA, unless they previously decided to insert a compulsory clause in a contract or international treaty establishing a spe-

[19] It is the case of the *Convention on the Settlement of Space Law Disputes* (1984) and its revision *Convention on the Settlement of Disputes Related to Space Activities* (1998). For the texts, see respectively *ILA Report of the Sixty-First Conference*, Paris, 1984, pp. 325-355, and *ILA Report of the Sixty Eighth Conference*, Taipei, 1998, pp. 239–275.

[20] For a further analysis of this instrument, see, among others, C. Arbaugh, *Gravitating Toward Sensible Resolution: The PCA Optional Rules for the Arbitration of Disputes relating to Outer Space Activities*, in *Georgia Journal of International and Comparative Law*, p. 848 ss.; G. J. Duberti, *Optional Rules for Arbitration of Disputes Relating to Outer Space Activities Permanent Court of Arbitration (PCA). An Excellent Opportunity for Progressive Development of Space Law*, in *Proceeding of the International Institute of Space Law*, The Hague, 2013, p. 143 ss.; C. Guzman Gomez, The Optional Rules of Arbitration of Disputes Relating to Outer Space Activities of the Permanent Court of Arbitration, a Real Option for the Solution of Conflicts in Space Matters?, in Proceedings of the International Institute of Space Law, The Hague, 2012, p. 756 ss; F. Pocar, *An Introduction to the PCA's Optional Rules for Arbitration of Disputes relating to Outer Space Activities*, in *Journal of Space Law*, 2012, p. 185 ss.; F. Tronchetti, *The PCA Rules for dispute settlement in outer space: A significant step forward*, in *Space Policy*, 2013, p. 181 ss.; L. Viikari, Towards More Effective Settlement of Disputes in the Space Sector, in Lapland Law Review, 2011, p. 226 ss. For a more technical discussion concerning the validity of PCA Optional Rules for specific satellite services, see, A. Loukakis, *The New HPCA's Optional Rules for Arbitration and Their Relevance to Dispute Arising From Erroneous Navigational Signals*, in *Proceedings of the International Institute of Space Law*, The Hague, 2014, p. 53 ss.; Macedo Scavuzzi Dos Dantos, *The PCA's Optional Rules for the Arbitration of Disputes Relating to Outer Space Activities and Dispute Resolution in the ITU Regulatory System*, in *Proceeding of the International Institute of Space Law*, The Hague, 2013, p. 157 ss.; F. Von Der Dunk, *About the New PCA Rules and their Application to Satellite Communication Disputes*, in M. Hofmann (ed.), *Dispute resolutions in satellite communications and space law*, Baden-Baden, 2015, p. 118 ss.

cific duty in this sense. Another major merit of this instrument is that the decision taken by the arbitrator (or the panel of arbitrators) established according to the rules set forth in the Optional Protocol, is binding upon the parties. Third, arbitration is a flexible mechanism, and applicable law is decided by the parties.[21]

Moreover, this mechanism is appropriate as it preserves the confidentiality of the information at stake, as the decision is not made public, unless otherwise agreed. This feature is particularly important because of security concerns: States are normally reluctant to share their sensitive information on space assets, which are normally dual use. Private enterprises also prefer to keep space assets' data secret, for example due to their interests in intellectual property rights. Another important aspect that should not be neglected is that the *PCA Outer Space Rules* take due account of the technical nature of space activities and the necessity for specialized experts to provide legal and technical support during arbitral proceedings. For this reason, Article 10(4) states that the PCA Secretary-General for the purpose of assisting the parties in appointing arbitrators will make available a list of persons considered to have expertise in space legal matters. Similarly, Article 29(7) refers to a list of experts in scientific or technical matters.

In the light of the aforesaid characteristics, the *PCA Outer Space Rules* seem to be a valid instrument for the settlement of disputes related to ADR. Notwithstanding, the success of these rules in connection to ADR activities is dependent on the success of the rules as a whole. In particular, as has been authoritatively acknowledged, "their success depends entirely on how much confidence they can inspire in the international community".[22] The main argument in favor of their success is twofold: on the one hand, PCA Optional Rules can successfully contribute to the development of international space law under the auspices of the principle of legal certainty. On the other hand, we can expect that the *Outer Space Rules* will be as successful as other sets of special rules designed by the PCA and the UNCITRAL Arbitration Rules.[23]

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[21] Article 35 *PCA Outer Space Rules*: "1. In resolving the dispute, the arbitral tribunal shall apply the law or rules of law designated by the parties as applicable to the substance of the dispute. Failing such designation by the parties, the arbitral tribunal shall apply the national and/or international law and rules of law it determines to be appropriate. 2. The arbitral tribunal shall decide as *amiable compositeur* or *ex aequo et bono* only if the parties have expressly authorized the arbitral tribunal to do so. 3. In all cases, the arbitral tribunal shall decide in accordance with the terms of the contract, if any, and shall take into account any usage of trade applicable to the transaction".

[22] F. Pocar, An Introduction to the PCA's Optional Rules for Arbitration of Disputes relating to Outer Space Activities, in Journal of Space Law, 2012, p. 185 ss.

[23] Moreover, it seems that Brazil and Argentina are negotiating an accord in which the would include an arbitration clause explicitly referring to the Outer Space Rules. Apparently even the European Space Agency declared its willingness to insert a similar clause in future contracts. In this sense, see F. Tronchetti, The PCA Rules for dispute settlement in outer space: A significant step forward, in Space Policy, 2013, p. 187. One legal scholar suggested the possibility for the International Telecommunication Union to the same choice: "Finally, the Rules could easily be implemented within the ITU regulatory system at two different levels: (1) either directly by changing the ITU instruments to include these Rules for use either on an optional or mandatory basis, or (2) indirectly, whereby States and satellite service operators could include in their service agree-

However, more than 6 years after the adoption of these rules, there is no evidence of their practical implementation, as observed by members of the ILA Space Law Committee at the Johannesburg Conference in 2016.[24] Additionally, in the 2015 PCA Annual Report, after a brief reference to the *Outer Space Rules*, it is affirmed that in the last years the PCA has seen a growing number of investor State arbitrations in the area of outer space activities, referring to cases related to the issuance, approval, and suspension of licenses, alleged nationalizations, and tax reassessments in the context of satellite communications. One pending case involves a bilateral investment treaty claim against India relating to the allocation of the S-band spectrum for satellite communications.[25] However, it should be underlined that even though this case concerns space activities, the application of UNCITRAL Arbitration Rules has been requested. What happens in the future will thus demonstrate whether this is a symbol of the weakness of the *Outer Space Rules*, or a sign that States and private entities prefer to employ other procedural rules, whose functioning is well-known.[26]

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ments leases, or contracts specific provisions mandating the use of PCA's Space Rules to resolve conflicts that occur as a result of their activities in Outer Space", in J. Macedo Scavuzzi Dos Dantos, The PCA's Optional Rules for the Arbitration of Disputes Relating to Outer Space Activities and Dispute Resolution in the ITU Regulatory System, in Proceeding of the International Institute of Space Law, The Hague, 2013, p. 174.

[24] In its conclusions concerning *Dispute Settlement* "[t]he Chair points out that it is extremely difficult to prove a universal negative, even more so regarding even the application of the PCA Rules. We should therefore continue exploring whether these Rules have ever been made effective, that is to say, if they have ever been applied -for better or worse- anywhere in the world to date. As recommended by Masson-Zwaan the PCA could be of assistance in this quest. (In fact, the Chair had asked PCA officers about their awareness on the application of the Rules, and they had answered in the negative). She agrees we should approach organizations such as ESA, and private companies as well, to provide them with more information on the Rules, especially their positive aspects which make them consistent with the present scenarios. This is in line with Freeland's and Marboe's suggestion of further examining the pros and cons of the PCA Rules in certain cases. The recommendation is therefore to continue our task on this matter during the next biennium".

[25] *CC/Devas (Mauritius) Ltd., Devas Employees Mauritius Private Limited, and Telcom Devas Mauritius Limited v. The Republic of India.*

[26] In order to spread the knowledge of this new instrument, the PCA is organizing many informative round, even in cooperation with important institutions. In the 2015 Report it is said that "[i]n 2015, the PCA continued its engagement with industry representatives, practitioners, and academics in the field of space law. In collaboration with the Space Law, Communications Law, and Arbitration committees of the International Bar Association, Senior Legal Counsel Judith Levine co-chaired and moderated a panel on the suitability of arbitration for the effective resolution of diverse space-related disputes for the IBA's annual conference in Vienna. Also in 2015, the European Space Agency attended a PCA information seminar for intergovernmental organizations focusing on the PCA's dispute resolution services".

2.2.3 Questions That Remain Open

Even if it has been possible to establish that States and private entities can refer to some international mechanisms in order to settle their disputes concerning ADR activities, some other questions still remain to be answered.

Without claiming to be exhaustive, the first question to be addressed is the applicable law conundrum. As is well known, international space law does not include any treaty dealing with space debris management. Additionally, since there is not even an agreed *legal* definition of what a space debris is, the applicability of space treaties is questioned because there is no *consensus* as to whether space debris can fall within the definition of a space object. Eventually, a detailed *legal* definition of space debris is necessary to make it possible to clearly identify removable objects and to actually define a more precise framework to manage ADR operations effectively and deal with space disputes, too.

Other problems also arise, for example, regarding the interpretation of the jurisdiction and control principle, as well as the rights and duties of the State of registry.

Ultimately, however, an award rendered by an international court interpreting space law in the light of ADR will be important to establish an authoritative interpretation, concurring or not with the positions expressed by legal scholars so far. Besides, the fact that no *consensus* about these questions has yet been achieved, means that other disputes on the interpretation of space treaties and application in the context of ADR can be easily triggered.[27]

[27] More detailed analysis concerning legal issues at stake in relation to ADR are contained in the following research papers: J. Chatterjee, Legal Issues Relating to Unauthorized Space Debris Remediation, in Proceedings of the International Institute of Space Law, The Hague, 2014, p. 13 ss.; M. K. Force, Legal Implications of Debris Removal, in Proceedings of the International Institute of Space Law, The Hague, 2012, p. 727 ss.; M. K. Force, When the Nature and Duration of Space Becomes Appropriation: "Use" as a Legal Predicate for a State's Objection to Active Debris Removal, in Proceedings of the International Institute of Space Law, The Hague, 2013, p. 405 ss.; V. Gopalakrishnan, M. Y. S. Prasad, Space Debris Remediation – Common but Differentiated Responsibility, in Proceedings of the international Institute of Space Law, The Hague, 2013, p. 379 ss.; O. S. Stelmakh, Space Debris – Emerging Challenges, Common Concern and Shared Responsibility: Legal Consideration and Directions towards Secure and Sustainable Space Environment, in Proceedings of the International Institute of Space Law, The Hague, 2013, p. 353 ss. E. Vitt, Space Debris. Physical and Legal Considerations, in Space Policy, May 1989, p. 129 ss.; O. Volynskaya, G. Zhukov, Long-Term Sustainability of Space Activities versus Imminent Danger from Space: Is Space Law Ready to Meet the Challenge?, in Proceedings of the International Institute of Space Law, The Hague, 2013, p. 359 ss.

2.3 The Way Forward

Moving from the *status quo*, which can be absolutely improved, it is interesting to speculate on what would be the *optimum*, i.e. the best practicable solution to be implemented in order to acquire an efficient framework for the management of ADR activities, eventually equipped with mechanisms to solve disputes.

In particular, this paragraph responds to a recently presented proposal concerning the creation of an IGO tasked with the development and operation of active debris removal technology: an international Active Debris Removal Organization (hereinafter, ADRO).[28]

The author understands that the creation of a new specialized IGO would entail extended and politically difficult multilateral negotiations. After all, *consensus* on space related topics is not easy to achieve, as shown by international space law history: the five space treaties were concluded a long time ago, and subsequent normative production has always taken the form of non-legally binding soft law instruments, shaped by the ever-changing international relations, and the differentiation of actors involved. But in thinking about a new paradigm to be implemented, this is one of the best possible.

In the minds of the authors,[29] the ADRO would be a means to cooperate peacefully and reduce multilateral actions with the purpose of pushing States and stakeholders beyond the current legal impasse. In particular, the ADRO could cumulatively

> (i) accommodate the legal gaps on space debris in current international space law; (ii) share costs and liabilities; (iii) instigate renewed discussions and bypass political deadlocks in relevant forums; (iv) act as an institutionalized Transparency and Confidence-Building Measure in a nascent and uncertain domain of space activities, and, perhaps most importantly; (v) contribute to rapid amelioration of the space debris environment for the benefit of all mankind.[30]

In this sense, an ADRO could resolve most of the problems recalled above. In particular, it could be a means through which applicable law to ADR activities can be clarified once for all.

The main idea on which the proposed creation of an ADRO is actually based, i.e. the prominent role played nowadays by IGOs in the space arena, is shared by the writer, who recently proposed an analysis concerning the importance of IGOs, especially the International Telecommunication Union (hereinafter, ITU), in the implementation of Transparency and Confidence Building Measures in outer space activities.[31]

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[28] W. Munters, J. Wouters, The road not yet taken for defusing conflicts in active debris removal: a multilateral organization, Working Paper n°183, May 2017, available at https://ghum.kuleuven.be/ggs/publications/working_papers/2017/wp183munters.pdf (23.11.17).

[29] Cfr. *supra*.

[30] Cfr. *supra*, pp. 27–28.

[31] V. Nardone, The Implementation of TCBMs in Outer Space Activities: from the OST Principles to the International Space Governance Action, in Proceedings of the International Institute of

Taking the above into account, it is believed that the proposal concerning the creation of an ADRO could be efficiently updated with an additional characteristic, i.e. the provision of a tribunal or dispute settlement body with compulsory jurisdiction on matters concerning disputes on ADR among Parties to the Organization, which should be open not only to States, but also to private entities and stakeholders, as is the case in the ITU since the 1992/1994 institutional reform. Similar proposals have been frequently advanced in the field of space law, due to the lack of a specialized tribunal for space matters.[32]

2.4 Conclusions

This analysis has aimed at giving an overview of dispute settlement mechanisms in the context of ADR, from the perspective of public international law, bearing in mind that no dedicated instruments are available.

Current mechanisms have been analyzed based on their accessibility.

On the basis of the obligation of to settle disputes peacefully, States have the freedom to solve their controversies through diplomatic channels or adjudicative methods, including the brand-new *PCA Outer Space Rules*. Even if adjudicative methods of dispute settlement are preferable as they result in binding decisions, rather than proposals or recommendations, as is the case for diplomatic means, in the event of disputes concerning ADR, States may favor opting for political solutions that are able to preserve the confidentiality of space asset information. Nonetheless, it should be recalled that current adjudicative methods for dispute settlement are not compulsory.

As far as private entities are concerned, the *PCA Outer Space Rules* are the only accessible means. Even if their effectiveness has not yet been demonstrated, they constitute a valid instrument to be included in future contracts or treaties as a compulsory dispute settlement clause.

Space Law, 2017, (forthcoming). There, it is said that due to the difficulties connected with the creation of new binding treaties and IGOs mandated with space security, safety and sustainability issues, IGOs already existent can effectively try to support the implementation of TCBMs updating or renewing their mandate. Conversely, the idea here proposed is based on a different assumption, supporting the creation of a new specialized ADRO as an idea able to promote the advancement of the legal impasse around ADR legal framework. However, the importance of IGOs in outer space activities' management remains unchanged.

[32] In this sense, see G. M. Goh, Dispute Settlement in International Space Law. A Multi-Door Courthouse for Outer Space, Leiden-Boston, 2007; V. Veshchunov, E. Morozova, Establishment of a Specialized Tribunal under the International Telecommunication Union to Adjudicate Disputes as a Means to Improve the Efficiency of the Management of the Radio Frequency Spectrum, in Proceedings of the International Institute of Space Law, The Hague, 2013, p. 151 ss.

Speculating on an optimal solution in the future, the creation of an ADRO, equipped with a specialized tribunal or body provided with compulsory jurisdiction on disputes concerning ADR, has been supported.

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Chapter 3
Jurisdiction and Control Aspects of Space Debris Removal

Gordon Chung

Abstract In recent years, the unrestrained creation of space debris by space-faring nations has gradually converted the outer space into an extraterrestrial dumping site. In view of this ongoing concern, legalising space debris removal by a non-registering state, under the existing international space law regime, is essential to invert such growing trends in debris population. While Article VIII of the Outer Space Treaty ("OST") merely confers "jurisdiction and control" over a space object to the "State of registry," three specific aspects of this jurisdictional clause merit special attention, namely: the qualification of debris as a "space object", the distinction between "identifiable" and "unidentifiable" objects, and the continuity of the granted "jurisdiction and control." Particularly important is whether the granted "jurisdiction and control" attaches permanently to the registering state, or lapses with the conclusion of effective physical control. This article suggests that a balancing between the provisions of the OST, especially Articles I and IX, seemingly favours the latter view and, at the end of the day, the establishment of a hierarchy of needs is necessary to be able to prioritise the conflicting interests of states under modern space law.

3.1 Introduction

Space debris has been a prominent environmental problem associated with space activities for the past few decades.[1] In the late 1990s, the joint study by the Space Transportation Association ("STA") and NASA already expressed concern about the possible collisions of space debris.[2] In fact, the imaginings of science fiction may now be becoming a reality: following two major debris-generating break-up

[1] Lotta Viikari, *Environmental Aspects of Space Activities*, in handbook of space law 719 (Frans von der Dunk ed. 2015).

[2] Daniel O'Neil et al., *General Public Space Travel and Tourism*, vol. 2, Workshop Proceedings, NASA/CP-1999-209146, 7–8, 10, 12–13 (1999).

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incidents,[3] over 5500 debris particles were officially catalogued in July 2012.[4] Particularly given the absence of any binding international norms governing space debris,[5] humanity is currently living in a world where the sky has become a "celestial dumping ground," with many thousands of discarded satellites or unwanted space objects.[6] It should be noted that space debris, due to its high velocity,[7] endangers space assets by posing a significant collision threat to international space stations, spacecraft and other functional space objects.[8] In addition, space debris may also be dangerous to those on the Earth—a refrigerator-sized early ammonia servicer jettisoned from the International Space Station fell to Earth in 2008.[9]

Today, in light of the ever-increasing amount of debris, legalising space debris removal can facilitate greater space security. In fact, studies already show that the capability to remove existing space debris is essential to reverse growth trend in the debris population that lies in orbit around the Earth.[10] Some scholars go even further to argue that the mitigation of space debris has begun to be elevated into norms of customary international law, particularly in view of the ongoing commitment from several states to reduce debris.[11] Yet, from a legal point of view, is the act of removing or deorbiting space debris considered legitimate under current international space law?[12] This first begs the question of which state is legally entitled to remove space debris.[13] Indeed, the answer to this question must begin with an understanding

[3] Early in 2007, China carried out an anti-satellite (ASAT) test through the destruction of its polar-orbiting weather satellite. Two years later, the first accidental hypervelocity collision between Iridium 33 and Cosmos-2251 happened.

[4] Viikari, *supra* note 1, 721.

[5] Fabio Tronchetti, Fundamentals of space law and policy 20–21 (2013). The Inter-Agency Space Debris Coordination Committee ("IADC") had developed space debris mitigation guidelines in 2002, which later served as the basis for the formulation of the non-legally binding guidelines adopted by UNCOPUOS in 2009.

[6] Dirk C. Gibson, Commercial space tourism: impediments to industrial development 97 (2012). See also David Ashford, Spaceflight Revolution 6, 48, 53, 92, 96, 152 (2002).

[7] They can move around the Earth at a high speed of 7500 m/s.

[8] Tronchetti, *supra* note 1, 20.

[9] Drik C. Gibson, Terrestrial and Extraterrestrial Space Dangers: Outer Space Perils, Rocket Risks and the Health Consequences of the Space Environment 41 (2015).

[10] Alessandro Chiesa et al., *Enabling Technologies for Active Space Debris Removal: The Cadet Project*, in Space Safety is no Accident: The 7th IAASS Conference 29 (Tommaso Sgobba & Isabelle Rongier eds. 2015).

[11] See Ram S. Jakhu & Joseph N. Pelton, Global Space Governance: An International Study 345–346 (2017); I.H. Ph. Diederiks-Verschoor & Vladimír Kopal, An Introduction to Space Law 9–10 (2008): Michael Lobban, *Custom, Common Law Reasoning and the Law of Nations in the Nineteenth Century*, in The Nature of Customary Law: Legal, Historical and Philosophical Perspective 274 (Amanda Perreau-Saussine & James Bernard Murphy eds. 2007).

[12] Jakhu & Pelton, *supra* note 11, 344.

[13] *Id*, 344.

of the nature of the fundamental "jurisdiction and control" concept in the current space law regime.

3.2 An Overview of Article VIII: The Fundamental "Jurisdiction and Control" Clause in International Space Law

Most fundamentally, Article VIII of the Outer Space Treaty ("OST") constitutes a customary law obligation[14] and explicitly grants "jurisdiction and control" of a space object to the State of registry[15] for an *indeterminate* period of time.[16] Notably, this expression evolved from paragraph 7 of the 1963 UN Declaration,[17] which skilfully avoids any reference to a more sensitive notion of state sovereignty or national territoriality in an extraterrestrial context.[18] Accordingly, although the OST clearly prohibits national appropriation by any claim of sovereignty,[19] a state is still entitled to exercise its sovereignty over its registered space objects.[20] It is also noteworthy that Article VIII does not even prescribe any time factor limiting the retention of a State's jurisdiction and control over the space objects under its registry. Seemingly, the provisions of Article VIII imply that, as a general rule, "no State is entitled to telecommand, divert or destroy space objects not subject to its jurisdiction, *except by agreement, for good cause …*"[21]

As far as terminologies are concerned, the expression "jurisdiction and control" is an aspect of sovereignty.[22] Under Article VIII, "jurisdiction" and "control" should be read in totality and not in parts, as scholar Gabriel Lafferranderie has already pinpointed the inseparable nature of these two concepts—"jurisdiction should induce control, and control should be based on jurisdiction."[23] More specifically, the

[14] Bin Cheng, Studies in international space law Ch7 (1997).

[15] OST, art. VIII.

[16] Lotta Viikari, The environmental element in space law: assessing the present and charting the future 82 (2007).

[17] Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, annexed to the UNGA Resolution 1962 (XVII), ¶ 7.

[18] Bernhard Schmidt-Tedd & Stephan Mick, *Article VIII*, in I Cologne Commentary on Space Law – Outer Space Treaty 520–521 (Stephan Hobe, Bernhard Schmidt-Tedd & Kai-Uwe Schrogl eds. 2017).

[19] OST, art. II.

[20] Schmidt-Tedd & Mick, *supra* note 18, 520.

[21] Clarence Wilfred Jenks, Space Law 238 (1965) (emphasis added).

[22] See Vladlen S. Vereshchetin, *International Space Law and Domestic Law: Problems of Interrelations*, 9 Journal of Space Law 31, 32 (1981).

[23] Gabriel Lafferranderie, *Jurisdiction and Control of Space Objects and the Case of an International Intergovernmental Organization (ESA)*, 54 German Journal of Air and Space Law (ZLW) 228, 231 (2005).

term "jurisdiction" here is understood to mean the "legislative, executive and juridical power" exercised by the State of registry in relation to personnel and objects in outer space.[24] In contrast, the term "control" refers to the "exclusive right and the actual possibility to supervise the activities" of a space object or person and,[25] in particular, activities that are aimed at "monitoring the technical condition of the space object,"[26] thereby allowing states to fulfil their obligations under Article VI of the OST.[27] Hence, due to the implicit constraint imposed by Article VIII, if a state, or a state licensed actor, desires to remove a space object, it can only legally do so "if it has legal jurisdiction and control over that space object or prior permission from the State of registry."[28] This then prompts the question of how a state can be qualified to be a "State of registry" in accordance with Article VIII, especially in the context of space debris removal.

3.3 Compelling Criteria for the Grant of "Jurisdiction and Control" Over Space Debris Under Article VIII

3.3.1 Condition 1: Is Space Debris Qualified as a "Space Object"?

As a starting point, one must note that Article I (d) of the Liability Convention (LC) defines a "space object" as including the "component parts of a space object as well as its launch vehicle and parts thereof."[29] This first begs the question of whether space debris can actually amount to "component parts" and thus fall squarely within the definition of a "space object" under international space law. However, the definition provided under the LC is merely considered as a "partial definition."[30] Since there is no clear definition[31] of the term "space object," space law scholars attempt to answer this question by resorting to the application of two legal theories—the

[24] See Howard Baker, Space Debris: Legal and Policy Implications 68 (1989); Vereshchetin, *supra* note 21. See further Schmidt-Tedd & Mick, *supra* note 18, 521 (notably, a threefold distinction between "territorial," "quasi-territorial" and "personal" jurisdiction is generally made under public international law).

[25] Schmidt-Tedd & Mick, *supra* note 18, 521.

[26] See Baker, *supra* note 24, 68.

[27] Schmidt-Tedd & Mick, *supra* note 18, 521–522.

[28] Ram Jakhu, *Active Debris Removal - An Essential Mechanism for Ensuring the Safety and Sustainability of Outer Space*, 49th Session of the Scientific and Technical Subcommittee Committee on the Peaceful Uses of Outer Space, 14 (2012).

[29] LC, art. I(d).

[30] Stephen Gorove, *Toward a Clarification of the Term "Space Object": An International Legal and Policy Imperative?*, 21 J. Space L. 11, 13–14 (1993).

[31] Baker, *supra* note 24, 80 (criticizing that the definition under Article I is "riddled with uncertainty").

spatialist and the *functionalist* approaches.[32] The spatialist approach, seeking to identify a physical boundary between airspace and outer space, interprets this generic term to cover any spacecraft, space vehicles and satellites that are physically located in an extraterrestrial environment.[33] Simply put, anything launched by man for a mission into outer space can be properly regarded as a "space object."[34] To the contrary, the functional approach[35] defines "space objects" as "any space instrument in its *operational* state," regardless of its physical location.[36] William Wirin adds to this definition by construing the expression to mean objects used in outer space "for collecting and transmitting information or for transportation and manufacturing processes […]"[37] Accordingly, under both the spatialist[38] and functionalist approaches,[39] it seems that space objects should, at a minimum, include those located and functioning on the Moon or other celestial bodies.

While there has been no universal definition of what actually constitutes a "space debris,"[40] it is understood to cover all man-made objects, including fragments and elements thereof, which are "non-functional" in outer space and thus serve no useful purpose.[41] More specifically, "non-functional spacecraft and orbital operations," debris generated by accidental collisions or intentional destruction of space objects, as well as "debris accidentally or deliberately released during normal mission operations", are all caught by the definition of "space debris."[42] At first sight, this ele-

[32] Jakhu & Pelton, *supra* note 11, 54–55.

[33] Bin Cheng, *Space Activities, Responsibility and Liability for*, 11 Encyclopedia of Public International Law 299–303 (1989); CHENG, *supra* note 14, 462. *See also* the Draft definitions submitted to Legal Sub-Committee of the Liability Convention, in which they agree that "space object must be designed for movement in outer space."

[34] See John Qu, Alfred Powell & M.V.K. Sivakumar eds, Satellite-Based Applications on Climate Change (2013); Vladimír Kopal, *Some Remarks on Issues Relating to Legal Definitions of "Space Object," "Space Debris," and "Astronaut,"* Proceedings 37th Colloquium 99–108 (1994).

[35] *See* Baker, *supra* note 24.

[36] *Id*.

[37] William B. Wirin, *Space Debris and Space Objects*, 34 Proc. Coll. L. Outer Sp. 45, 46 (1991).

[38] *See* Cheng, *supra* note 14, 425 (there is a clear line between air and space, although no consensus as to where boundary should be drawn); Vernon Nase, *Delimitation and the Suborbital Passenger: Time to End Prevarication*, 77 J. Air L. & Com. 747, 754 (2012) ("geographical" boundary between airspace and outer space).

[39] *See* Baker, *supra* note 24.

[40] Jinyuan Su, *Control Over Activities Harmful to the Environment*, in Routledge Handbook of Space Law 79 (2016).

[41] See, e.g., Inter-Agency Space Debris Coordination Committee, *IADC Space Debris Mitigation Guidelines,* IADC-02-01, Revision 1, 5 (2007); United Nations, *Technical Report on Space Debris*, A/AC.105/720 1999, ¶ 6; I.H.Ph. Diederiks-Verschoor, *Harm Producing Events by Fragments of Space Objects (Debris)*, Proceedings of the 25th Colloquium on the Law of Outer Space of the IISL, 1-4 (1982); I.H.Ph. Diederiks-Verschoor, *Legal Aspects of Environmental Protection in Outer Space Regarding Debris*, Proceedings of the 30th Colloquium on the Law of Outer Space of the IISL, 131 et seq (1987).

[42] See, e.g., Baker, *supra* note 24, 3–9; Detlef Alwes, Marietta Benkö & Kai-Uwe Schrogl, *Space Debris: An Item for the Future*, in international space law in the making: current issues in the UN

ment of "non-functionality" falls short of fulfilling the *functionalist* definition and thus should, in theory, deprive space debris of its status as a "space object." But to do so would ignore the practical realities of space exploration: in particular, excluding space debris—the most common and hazardous form of potential damage associated with space activities—from the definition of "space object" would give rise to loopholes that undermine space safety and render the international space law regimes, including the Liability Convention, largely meaningless.[43] Further, the criterion of "technical functionality" is not a desirable determinant for distinguishing space debris from other objects, as even inactive man-made objects can be valuable in the sense that they may be reserved for future space activities.[44] In any event, a practical interpretation of "space object" seems more appropriate in view of the increasing dangers posed by space debris today.[45] Accordingly, as far as jurisdiction and control aspects are concerned, a more reasonable proposition is that any object that is launched into outer space and satisfies the spatialist approach constitutes a "space object" for the purpose of Article VIII.[46]

3.3.2 Condition 2: The General Capability of Being Identified?

3.3.2.1 Distinction Between "Identifiable" and "Unidentifiable" Objects

Furthermore, there is a second limitation on the applicability of the "jurisdiction and control" clause in the context of space debris removal—the *origin* of the debris concerned must be capable of being identified.[47] In particular, in ascertaining the space-object nature of any space debris, the distinction between "identifiable" and "unidentifiable" objects must first be made.[48] In fact, this theoretical distinction has long appeared in international maritime law, under which a state is only entitled to destroy any "unidentifiable flotsam and jetsam," but is prohibited from damaging derelict vessels that still carry indicia of national origin unless consent is duly obtained from the owner and its insurance company.[49] Following this analysis, commentator Cargill Hall concluded that:

Committee on the Peaceful Use of Outer Space 234 (Marietta Benkö & Kai-Uwe Schrogl eds. 1993); Heiner Klinkrad, Space Debris: Models and Risk Analysis 18–27 (2006).

[43] Viikari, *supra* note 1, 736.

[44] *Id*, 719.

[45] Viikari, *supra* note 16, 71.

[46] Diederiks-Verschoor & Kopal, *supra* note 11, 9.

[47] Wayne White, *The Legal Regime for Private Activities in Outer Space*, in Space: the Free-Market Frontier (Edward Lee Hudgins & David Boaz eds. 2002) 88 (emphasis added).

[48] *Id*.

[49] Cargill Hall, *Comments on Salvage and Removal of Man-Made Objects from Outer Space*, 33 J. Air L. & Com. 288, 294 (1967).

> [I]t is reasonable to infer from maritime law that title to identifiable, inactive, man-made objects in space is retained by the flag state and is not affected by abandonment. This is made explicit in Article VIII of the treaty on outer space.[50]

In other words, once the origin of a space debris is determined, it can be properly be classified as a "component part,"[51] and is thus capable of attracting protection under Article VIII. At the end of the day, a close reading of Article VIII indicates that the power to remove or destroy *identifiable* space debris is ultimately confined to the State of registry.[52] This brings us to the practical importance of the identification process of registered space objects.

3.3.2.2 The Identification Process and Registration of Space Objects

To facilitate the identification of space objects for the purposes of Article VIII, all states and private entities should register the details of their space missions with the Secretary-General of the United Nations.[53] Identification of space objects mainly involves two processes: detection and identification—only the latter of which is partially addressed by the registration mechanism provided under the Convention on Registration of Objects Launched into Outer Space ("Registration Convention"),[54] where "a dual system of national and international registration" has been established.[55] As a starting point, the launching state shall register its space object that is launched into earth orbit or beyond in a national registry.[56] More unprecedentedly, the Registration Convention created, for the first time in history, an international registry[57] and required states to supply certain information regarding their space object to the Secretary-General of the United Nations.[58] Notably, by virtue of Article VIII, it is only the State of registry that shall have exclusive jurisdiction and control over the respective space object as well as the sole authority to remove its debris from outer space.

In other words, the most compelling incentive for registration is that the registering state can more effectively regulate activities connected to the space object,

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[50] *Id*, 295.

[51] White, *supra* note 47.

[52] Hall, *supra* note 49, 295–296 (emphasis added).

[53] H.A. Wassenbergh, Principles of Outer Space Law in Hindsight 74 (1991).

[54] Howard Baker, *Regulation of Orbital Debris – Current Status*, in Preservation of near-earth space for future generations 182 (John A. Simpson ed. 2007).

[55] A.A. Cocca, *Registration and Space Objects*, in Manual on Space Law 180 (N. Jasentuliyana & R.S.K. Lee eds. 1979).

[56] Registration Convention, art. II(1).

[57] Cocca, *supra* note 55, 180.

[58] Stephen Gorove, *Convention on Registration of Objects Launched into Outer Space: Analysis and Commentary*, 19 IISL 292 (1976).

impose conditions on private operators,[59] and even make national laws applicable to both the space object and its personnel.[60] If an object has not fulfilled the requirement of registration, the act of launching and the ownership of the object may become highly relevant in determining the state with "jurisdiction and control" over it.[61] Supplemental to these rules of registration, Article VI of the Registration Convention further requires "States possessing space monitoring and tracking facilities" to aid in the identification of space debris that has caused damage.[62] But in any event, the act of registration would offer better protection to the State of registry and its registered space object (or its debris) under international space law.

3.4 The Continuity of Jurisdiction: A Permanent "State Property" or An Abandoned Space Object?

Most importantly, as far as the issue of space debris removal is concerned, there has been a long-standing debate on whether the jurisdictional power granted by Article VIII "attaches permanently regardless of an absence of continued control, effective physical control or the state of being of the object," or "lapses with the conclusion of effective physical control – an abandonment of the object – as in maritime law."[63] The outcome of this debate is highly critical for the legitimacy and feasibility of space debris removal, and it thus merits special attention.

3.4.1 The Traditional View: Absolute or Exclusive Nature of Jurisdiction

Indeed, the majority of literature veers towards the view that space objects almost invariably remain under the jurisdiction of the State of registry.[64] Early in the 1980s, Vitaliy Bordunov took a firm stance to formulate the so-called "principle of the

[59] Irmgard Marboe, *Small is Beautiful? Legal Challenges of Small Satellites*, in Private law, Public Law, Metalaw and Public Policy in Space: A Liber Amicorum in Honor of Ernst Fasan 10 (Patricia Margaret Sterns & Leslie I. Tennen eds. 2016).

[60] See Julian Hermida, Legal Basis for a National Space Legislation 63 (2004); Julian Hermida, *Space Registry*, 24 International Business Lawyers 383 (1996).

[61] Jakhu & Pelton, *supra* note 11, 344.

[62] Registration Convention, art VI. *See also* National Research Council et al., Orbital Debris: A Technical Assessment 186 (1995).

[63] Hall, *supra* note 49, 290–291.

[64] See, generally, Wayne White, *Salvage Law for Outer Space*, Engineering, Construction, and Operations in Space III, Space '92, Proceedings of the Third International Conference, Denver, Colorado 2412, 2417 (1992); I.H. Ph. Diederiks-Verschoor, *The Increasing Problems of Space Debris and Their Legal Solutions*, in Proc. Thirty Second Colloquium on the Law of Outer Space IISL, 77 (1990).

immunity of space objects" which would "rule out the use of force … by one state in regard to the space object which is the property of another."[65] Following this proposition, Article VIII guarantees the right of disposal to be reserved and, in effect, transforms a registered space object into a "state property," which prohibits other states from "tampering with the orbit, capturing it or putting it out of the commission."[66] In fact, the arguably indisposable nature of the jurisdictional power can be further deduced from the language of Article VIII itself, which explicitly stipulates that "[o]wnership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, *is not affected by their presence in outer space or on a celestial body or by their return to the Earth*."[67] In other words, Article VIII entitles a state to possess a space object for the mere purpose of returning it.[68]

Under this interpretation, even the unilateral declaration of any state to consider a registered space object "derelict" would have no effect on the jurisdiction of its State of registry. Notably, a "derelict" space object has been defined as "one which is abandoned and deserted by those who were in charge of it, without hope on their part of recovering it and without intention of returning to it."[69] Based on this definition, space debris could be properly described as an abandoned space object and may thus constitute a "*res derelicta*"—meaning that the owner has already given up the ownership of his possession.[70] Nonetheless, in international space law, ownership is entirely irrelevant in determining the appropriate state under the obligation to register a space object.[71] Hence, there is no correlation between "ownership" of a space object and the state which has "jurisdiction and control" over it.[72] In other words, even a cross-border transfer of ownership could not justify replacement of the original State of registry.[73]

This proposition is further supported by the fact that there is "no apparent legal basis" in the five UN Treaties on Outer Space expressly allowing the transfer of registration of—and thus jurisdiction and control over—a space object from one state to another during its operation in orbit.[74] Consequently, in the absence of any

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[65] Vitaliy D. Bordunov, *Rights of States as Regards Outer Space Objects*, in 24 Colloquium L. Outer Space 89, 91 (M. Schwartz ed. 1981).

[66] *Id*, 91.

[67] OST, art. VIII (emphasis added).

[68] D.M. Wanland, *Hazards to Navigation in Outer Space: Legal Remedies and Salvage Law*, I J. Astrolaw 1, 27 (1985).

[69] *Id*.

[70] George T. Hacket, Space Debris and the Corpus Iuris Spatialis 194 (1994).

[71] Schmidt-Tedd & Mick, *supra* note 18, 540.

[72] J. Sztucki, *Legal Status of Space Objects*, 9 Proc. Coll. L. of Outer Space 108, 115 (1967).

[73] Schmidt-Tedd and Mick, *supra* note 18, 540.

[74] Committee on the Peaceful Uses of Outer Space ("COPUOS"), *Responses to the set of Questions provided by the Chair of the Working Group on the Status and Application of the Five United Nations Treaties on Outer Space*, UN Doc. A/AC.105/C.2/2012/CRP.11, 4-5 (22 March 2012) (hereinafter Responses to the set of Questions) (see, particularly, the opinions of Belgian delegation).

mechanism under present space law regimes to transfer jurisdiction, control or liability of a space object,[75] a state by merely renouncing its rights of ownership "is not released from those obligations which rest upon it as the result of launching the object or from the further consequences thereof."[76] At the end of the day, a literal reading of Article VIII seemingly suggests that a space object is theoretically incapable of being abandoned to become a *res nullius* because it, in theory, permanently remains the property of the State of registry. Even though there is some suggestion that the provisions of Article VIII can possibly be extended to international organizations, they could at most only exercise *limited* jurisdiction and control over a registered space object and its personnel,[77] according to the principle of *spécialité légale*, which "restricts the sovereign powers of an organization of public international law to no more than the powers and mandates for which the organization was established."[78]

Following this line of reasoning, the doctrine of "permanency of jurisdiction and control" apparently applies to space debris.[79] Because of the *absolute* nature of jurisdiction, the inspection of space objects cannot be performed without the registering state's consent.[80] Article 20 of the ILC Articles on State Responsibility reflects the basic international law principle of consent, stating that "valid consent by a State to the commission of a given act by another State precludes the wrongfulness of that act in relation to the former State to the extent that the act remains within the limits of that consent."[81] However, the consent must be expressed by the state rather than presumed.[82] Accordingly, without express consent from the State of registry, space debris cannot be disposed of or otherwise interfered with, "by electronic or other means."[83] To do otherwise would amount to an "improper assertion of jurisdiction over sovereign property."[84] That being said, this "jurisdiction and control" clause contains a "two-fold concept"[85] and it can be portrayed as a potential double-edged sword in practice: while other nations are prohibited from removing registered

[75] Joseph N. Pelton, New Solutions for the Space Debris Problem 74 (2015).

[76] Manfred Lachs, The Law of Outer Space: An Experience in Contemporary Law-Making 73 (1972).

[77] Responses to the set of Questions, 5 (emphasis added).

[78] *Id*.

[79] Baker, *supra* note 54, 182.

[80] Baker, *supra* note 24, 69–71 (emphasis added).

[81] Rep. of the Int'l Law Comm'n, 53rd Sess., April 23-June 1, July 2-Aug. 10, 2001, Draft Articles on Responsibility of States for Internationally Wrongful Acts, U.N. Doc.A/56/10; GAOR, 56th Sess., Supp. No.10, art. 20 (2001) [hereinafter ILC articles].

[82] Joyeeta Chatterjee, *Legal Issues Relating to Unauthorised Space Debris Remediation*, 65 Int'L Astronautical Cong. 1, 6 (2014).

[83] Jenks, *supra* note 21, 238.

[84] Malcolm Russell, *Military Activities in Outer Space: Soviet Legal Views*, 25 Harv. Int'l. L. J. 153, 184 (1984). *See also* Brian Weeden, *Overview of the Legal and Policy Challenges of Orbital Debris Removal*, 27(1) Space Policy 41 (2011).

[85] Schmidt-Tedd and Mick, *supra* note 18, 524.

space objects of another state, the State of registry—as the appropriate state—is liable for any damage caused by the debris of such space objects.

3.4.2 The Practical View: Termination of Jurisdictional Power Under Special Circumstances

Yet, particularly in view of the ever-increasing problem of space congestion, exceptions to the principle of "permanency of jurisdiction and control" should be developed and applied sparingly in certain circumstances.[86] Today, a more modern or realistic interpretation of Article VIII suggests that any grant of jurisdiction under this clause is "non-exclusive."[87] Arguments in favour of a more restrictive concept of "jurisdiction and control" can be divided primarily into two categories of cases: (1) an expressed or implied act of abandonment, and (2) a situation of peril.

3.4.2.1 Scenario 1: An "Expressed" or "Implied" Act of Abandonment

First, a more restrictive view of Article VIII is that legal control and jurisdiction over registered space object ceases to exist when there is an "expressed" or "implied" act of abandonment,[88] arguably due to a loss of *animus dominandi* ("the desire to power").[89] Indeed, in most circumstances, a space object should not be presumed to be abandoned unless there is a public statement or declaration by the registering state.[90] That being said, a space object can still be abandoned impliedly, if the state of registry has no longer made any attempt to recover it over a long period of time,[91] which can be evident from the cessation of regular or periodic use of the object or the loss of control over the object in the absence of any prompt action to re-establish such control.[92] Based on the foregoing analysis, inoperative space objects might be considered abandoned and thus not subject to national jurisdiction in certain circumstances.[93]

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[86] Hacket, *supra* note 70, 209.

[87] Mark J. Sundahl, *Legal Status of Spacecraft*, in Routledge Handbook of Space Law 44 (Ram S. Jakhu & Paul Stephen Dempsey eds., 2016).

[88] Philip De Man, Exclusive Use in an Inclusive Environment: The Meaning of the Non-Appropriation Principle for Space Resource Exploitation 372 (2016).

[89] Cheng, *supra* note 14, 416.

[90] Wayne White, *Real Property Rights in Space*, 40 Proceedings Colloq. L. Outer Space 370, 380 (1998).

[91] Jenks, *supra* note 21, 240.

[92] *See* Man, *supra* note 88, 372; White, *supra* note 90, 380.

[93] *See* Hamilton DeSaussure, *An International Right to Deorbit Earth Threatening Satellites*, 3 Annals Air & Space L. 383 (1978). Art IX of the OST requires a State to carry out its space activities with due regard to the corresponding interests of all other countries.

3.4.2.2 Scenario 2: A "State of Peril" Circumstance

The second line of argument is that "jurisdiction and control" over registered space objects should terminate when it poses a source of danger for other states.[94] Generally speaking, in order to legitimately remove a space debris, the removing state is normally required to (1) notify the registering state of the threat imposed by the space debris; (2) consult with the registering state and give it a prior right of removal; and (3) independently verify the necessity of space debris removal.[95]

Even though a State of registry retains "jurisdiction and control" over its space objects, some scholars have clarified that "the [apparently] absolute nature of jurisdiction, control and ownership can be circumvented in certain cases."[96] In particular, an injured state is entitled to intercept a space object *without consent* of its registering state, *if the hazard presented by the object threatens the safety of other space activities*,[97] or *causes potentially harmful interference with the activities of any other legal entity*[98]—dubbed the "state of peril" situation. This is especially so when the State of registry, after being notified of such harmful interference, does not undertake to authorize its removal,[99] or remains negligent in deorbiting its debris, which causes damage to the legitimate space activities of other countries.[100] Further support for this proposition can be gleaned from customary international law, under which a state may have jurisdiction—the "national security jurisdiction"—to regulate a space object that poses a security threat to it.[101]

3.4.2.3 Competing Interests of States: A System of Priorities in Space Law?

It is worth noting that the above-discussed arguments, when read in the context of the OST regime, mainly arise from, and can perhaps be justified by, balancing two seemingly antagonistic provisions: the jurisdictional power of the registering state[102] and the observance of the "due regard" principle.[103] Hence, to understand the exact

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[94] Man, *supra* note 88, 372.

[95] *See* DeSaussure, *supra* note 93, 394; Viikari, *supra* note 16, 82.

[96] Tiyanjana Maluwa, International Law in Post-Colonial Africa 205 (1999); Craig Fishman, *Space Salvage: A Proposed Treaty Amendment to the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Space*, 26 Virginia J Int'l L 965, 965 (1986).

[97] Hamilton DeSaussure, *The Application of Maritime Salvage to the Law of Outer Space*, 28 Proc. Coll on the Law of Outer Space 127, 127 (1985) (emphasis added).

[98] Howard A. Baker, *The ESA and US Reports on Space Debris – Platform for Future Policy Initiatives*, Space Policy 332, 336 (1990) (emphasis added).

[99] *Id,* 336.

[100] Wassenbergh, *supra* note 53, 74.

[101] Sundahl, *supra* note 87, 44.

[102] OST, art. VIII.

[103] DeSaussure, *supra* note 93, 390.

nature of the "jurisdiction and control" clause, Article IX of the OST—a provision requiring a state to carry out its outer space activities with "due regard" to the corresponding interests of all other countries[104]—merits special attention. Specifically, it imposes a duty to undertake space activities with a standard of care, taking in consideration the rights and legitimate interests of all other nations.[105] It also requires states sharing a common amenity to adjust their space activities with reasonable protective measures.[106] More notably, this so-called "due regard" principle is understood as an obligation to take into account the legal rights of other states, "both prior to (planned) and during (ongoing) space activities."[107] Accordingly, the accidental or intentional creation of dangerous (inoperative) space debris before or during any space mission, at the potential expense of the interests of other space-faring nations, would indeed run counter to the "due regard" principle. Following this analysis, it seems that the jurisdictional power of registering states should somehow be circumscribed or, at the very least, operate within the confines of Article IX.

In addition to Article IX, the need to harmonise the competing interests of states is further highlighted by the so-called "common interest" principle,[108] which mandates that space activities shall be carried out for the benefit and *in the interests of all countries*.[109] This "common interest" principle, at a minimum, imposes a *negative* duty on states to refrain from disregarding or harming the interests of other nations when conducting space activities ("no-detriment requirement").[110] More specifically, Article I prevents a state from interfering with or hampering the legitimate activities of other countries.[111] It follows that the "no-detriment requirement" should be employed to counteract the restrictive effect of Article VIII, particularly in light of the potential dangers posed by space debris to the ongoing space activities

[104] OST, art. IX.

[105] Sergio Marchisio, *Article IX*, in I Cologne Commentary on Space Law 175 (Stephan Hobe et al., eds. 2009). *See also* Fisheries Jurisdiction (*U.K. v Ice.*), Merits, 1974 I.C.J. Rep. 3, ¶72 (July 25) (recognizing that "States have an obligation to take full account of each other's rights"). *See also* Gordon Chung, *The Emergence of Environmental Protection Clauses in the Outer Space Treaty: A Lesson from the Rio Principles*, in A Fresh View on the Outer Space Treaty 2 (Annette Froehlich ed. 2018).

[106] Hacket, *supra* note 70, 99.

[107] M.C. Mineiro, *Article IX's Principle of Due Regard and International Consultations:An Assessment in Light of the European Draft Space Code-of-Conduct*, The 5th Eilene M.Galloway Symposium on Critical Issues in Space Law 1, 3 (2010).

[108] Stephen Gorove, *The Geostationary Orbit: Issues of Law and Policy*, 73 Am. J. Int'l L. 444, 448 (1979).

[109] OST, art. I(1) (emphasis added).

[110] Ricky Lee, Law and Regulation of Commercial Mining of Minerals in Outer Space 198 (2012); Edwin W. Paxson, *Sharing the Benefits of Outer Space Exploration: Space Law and Economic Development*, 4 Mich. J. Int'l L. 487, 494 (1993); H.A. Wassenbergh, *Speculations of the Law Governing Space Resources*, 5 Annals Air & Space L. 611, 614 (1980). *See also* the discussion in Gordon Chung, *An Incentivising Regime For Private Enterprises: The Enduring Benefits Derived From The Commercialisation Of Outer Space*, The Fifth Manfred Lachs International Conference on Global Space Governance and the UN 2030 Agenda (MLC17) 1, 5–6 (2017).

[111] Paxson, *supra* note 110, 494; Wassenbergh, *supra* note 110, 614.

of other countries. Accordingly, even an application of the "common interest" principle would likely point to a conclusion that the jurisdiction and control (i.e. national interests) of a registering state should not inevitably prevail.

The above analysis on the competing interests of states, especially in the context of space debris removal, draws us to the question of how we can determine which interest prevails. While the OST implicitly recognizes the competing interests among different states,[112] the present space law regimes fail to lay down any rules for designating priority among those interests.[113] Indeed, as envisaged by commentator Schwetje, it is necessary, and ultimately inevitable, for modern space law to develop a hierarchy of needs or a system of priorities,[114] which in my view should include, from highest to lowest, (a) the prevention of life-threatening dangers, (b) the maintenance of international peace and security in outer space, (c) the advancement of a state's interests (including strategic and economic interests). As far as category (a) is concerned, international space law should confer upon a state the right to remove the space debris belonging to another in a situation in which human life is directly threatened. In other words, the state that is exposed to such threat is entitled to take action against the debris, even to the extent of destroying the threatening object.[115] With respect to category (b), a widened concept of "peace and security" that goes beyond the "traditional inter-state conflict model" has to be adopted,[116] especially in light of the environmental degradation caused by space debris. Notably, states are under a *general duty* to maintain "international peace and security,"[117] and this duty extends to cover the preservation of collective human interests that transcend any particular state, including the removal of hazardous space debris which is capable of inhibiting the sustainable, future use of outer space.[118] Following these propositions, the possibility of removing space debris should, at the very least, be available to categories (a) to (b), where there are imminent dangers or security threats deriving from an over-populated space debris environment.

More controversial are, however, cases concerning category (c)—when and how may a state remove the registered space object of another for "purely economic

[112] OST, art. IX provides that "States Parties […] shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the *corresponding interests of all other States Parties to the Treaty*" (emphasis added).

[113] U.S Congress, Office of Technology Assessment, *Orbiting Debris: A Space Environmental Problem-Background Paper*, OTA-BP-IS C-72, 30 (1990).

[114] F. Kenneth Schwetje, *Space Law: Considerations for Space Planners*, 12 Rutgers Computer & Tech. L.J. 245, 279 (1987).

[115] *Panel Discussion*, in Preservation of Near-Earth Space for Future Generations 240 (John A. Simpson ed. 2007).

[116] Michael Mineiro, Space Technology Export Controls and International Cooperation in Outer Space 174 (2012).

[117] OST, art. III states that States "shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies […] in the interest of maintaining international peace and security […]." *See also Id*, 172–173 (emphasis added).

[118] *See Id*, 172–173.

reasons"?[119] In such cases, it appears that a balancing exercise should be carried out, on a case-by-case basis, between the potential benefits deriving from the proposed space debris removal and the costs of actions, be they monetary[120] or non-monetary, borne by the registering state in deorbiting its object. In any event, one should recognize the policy reason behind active space debris removal: the embracement of such a system could eventually transform current environmental challenges into "business opportunities" for the global space sector, specifically by facilitating the development of novel technologies for space debris mitigation and the design of non-debris generating missions.[121] At the end of the day, even though the State of registry may be expected to pay for space debris removal missions, it still has recourse to the owner of the space object and its debris.[122]

3.5 Conclusion

At present, the congestion of space debris is a serious problem that might well paralyze the progressive development of space activities. While the mitigation of space debris is an almost inevitable solution in light of the ever-increasing debris population, the question of legitimacy of such acts (i.e. deorbiting or removing a registered space object of another state) remains unanswered. Notably, the "jurisdiction and control" clause laid down in Article VIII of the OST is the major barrier under present space law regimes. As the expression "jurisdiction and control" is an attribute of sovereignty, a state can legally remove a registered space object only if it satisfies the requirement of Article VIII or obtains prior consent from the State of registry. Therefore, understanding the exact nature of the jurisdictional power conferred upon the registering states in relation to their space objects is a paramount priority to facilitating the viability of space debris removal.

While the expression "space debris" generally refers to cover all man-made objects that are non-functional in outer space, this criterion of "technical functionality" is not a desirable determinant for distinguishing space debris from other objects, and it seemingly fails to satisfy the *functionalist* dimension of "space object." But in practice, a close examination of the language of Article VIII suggests that space debris, despite its lack of definitive legal meaning, is still caught by the definition of "space object" and thereby subject to the jurisdiction and control of the State of registry. The reason behind this is simple: as a matter of policy, present space laws, especially the Liability Convention, would be rendered meaningless if "space debris"—one of the greatest hazards in space—were excluded from their scope.

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[119] F. Kenneth Schwetje, *Current U.S. Initiatives to Control Space Debris*, 30 Proc. on L. Outer Space 163, 165 (1987).

[120] In fact, all methods of removing debris inevitably incur certain economic costs. *See* U.S Congress, Office of Technology Assessment, *supra* note 113, 6.

[121] Stella Tkatchova, Emerging Space Markets 99 (2017).

[122] Wassenbergh, *supra* note 53, 74.

Also, for space debris to fall within the ambit of Article VIII, its *origin* must be capable of being identified—the distinction between "identifiable" and "unidentifiable" objects must therefore be made. In practice, the State of registry retains the exclusive power to remove only its *identifiable* space debris. To cope with this issue the Registration Convention has created "a dual system of national and international registration" in furtherance of the identification process. At the end of the day, in order to exercise effective jurisdiction and control over the activities of their space objects under Article VIII, states are incentivized to comply with the requirement of registration.

It is noteworthy that two dichotomous views emerge as to whether the jurisdictional power granted by Article VIII attaches permanently to the State of registry or lapses with the conclusion of effective physical control. According to the traditional "principle of the immunity of space objects" or the doctrine of "permanency of jurisdiction and control," Article VIII effectively transforms a registered space object into a "state property." Notably, ownership is considered irrelevant in determining the appropriate state under the obligation to register a space object. It follows that space debris is theoretically incapable of becoming a "*res derelicta*." Without any mechanism to transfer the jurisdiction over and control of a registered space object, the jurisdictional power would rest permanently with the State of registry. Yet, according to a more practical interpretation of Article VIII, any grant of jurisdiction is "non-exclusive" in nature.

The apparently absolute nature of "jurisdiction and control" may be circumvented in two specific scenarios: (1) an expressed or implied act of abandonment and (2) a state of peril. More importantly, these two lines of reasoning can be justified by balancing two seemingly antagonistic provisions in the OST: the jurisdictional power of the registering state and the observance of the "due regard" principle. Specifically, Article IX requires states to undertake space activities with a standard of care, taking into account the legal rights of other states. The "no-detriment requirement" of Article I is also reflective of this principle, by imposing a negative duty on states to refrain from disregarding or harming the interests of other nations when conducting space activities.

The application of these principles reinforces the view that the jurisdiction and control of a State of registry should not inevitably prevail. In the future, it is inevitable for modern space law to develop a hierarchy of needs or a system of priorities, which includes, from highest to lowest, (a) the prevention of life-threatening dangers, (b) the maintenance of international peace and security in outer space, (c) the advancement of a state's interests (including strategic and economic interests). While space debris removal in categories (a) to (b) is normally justifiable, category (c) requires more scrutiny. At the end of the day, one should balance the potential benefits deriving from the space debris removal missions against the costs of actions borne by the registering state in deorbiting its object.

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Chapter 4
Between Active Debris Removal and Space-Based Weapons: A Comprehensive Legal Approach

Matteo Frigoli

Abstract The growing population of space debris has the potential to seriously compromise the exploration of and access to outer space. It is now generally agreed that large portions of Earth's orbits are on the threshold of an irreversible situation making the removal of non-functional space objects a necessity. While the technologies to carry out removal operations are being developed, the outer space legal regime has not kept the pace with these challenges. Active debris removal technologies present both opportunities and risks. The dual use nature of these technologies is one of the most challenging questions, as the same technology could be used to deorbit debris or damage functional satellites. In the light of these considerations, this analysis discusses how the space law regime applies to these issues with the purpose of setting out possible legal solutions based on the interrelations between active debris removal technologies and space weaponization.

4.1 Introduction

Outer space has proven to be a fundamental environment for scientific and economic progress, as well as for military and geopolitical interests. The linkage between states and space-based assets has become a key factor for development in a very wide range of fields, to the extent that without reliable satellites in orbit standards of living would deteriorate.[1] Indeed, it could be argued that if 30 or 40 years ago the progress of space-assets were an appendix of Earth's technology, today a major part of Earth's technological progress is basically linked to the goals of space-based assets.

[1] Joseph N. Pelton, *New Solutions for the Space Debris Problem* (Springer, 2015) at 1.

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A. Froehlich (ed.), *Space Security and Legal Aspects of Active Debris Removal*,
Studies in Space Policy 16, https://doi.org/10.1007/978-3-319-90338-5_4

But whilst, on the one hand, space activities and space assets have flourished, becoming key enablers of national and international infrastructures,[2] on the other hand, since the launch of Sputnik 1, space debris has begun to populate Earth's orbits, as every spaceflight potentially produces space debris.[3] These objects come from a large variety of sources, including, for example, the intentional destruction of satellites, the abandonment of stages of launch vehicles or parts of the spacecraft in orbit, and the creation of 'paint flakes' or aluminum oxide particles due to motor combustion or solar radiation.[4]

Currently, space debris is one of the most critical issues related to space exploration and use, with an estimated population of 29,000 objects larger than 10 cm, 750,000 objects from 1 cm to 10 cm, and 166 million objects from 1 mm to 1 cm orbiting the Earth.[5] This multitude of objects threatens to undermine the continued access to outer space. While the removal of space debris has become a necessity, the existing legal regime of outer space is silent about the lawfulness of such operations. Furthermore, space-assets capable of carrying out removal operations could be used for military purposes. Considering the high level of militarization of outer space and the competition between the major space powers, eventual unilateral removal operations could be a 'game changer' toward the risk of space weaponization.

4.1.1 Dealing with Growing Space Debris, the Gentle Mitigation and the Hard Removal

Basically, there are two main approaches that, so far, have been developed to address the issue of space debris. The first one sees the adoption of 'mitigation guidelines' as the main instrument to arrest the creation of new space debris. In fact, this is the only way in which the international community is currently dealing with the issue. International efforts to address the problem did not begin until 2002, when the Inter-Agency Space Debris Coordination Committee (IADC) published the document "IADC Space Debris Mitigation Guidelines".[6] Subsequently, this subject was discussed in the more general framework of United Nations Committee on the Peaceful

[2] NATO Parliamentary Assembly 'The space domain and allied defense' (Defense and Security Committee, Draft Report - 068 DSCFC 17 E, (20 March 2017) at 1.

[3] SpaceSecurity.org, Space Security 2013, at 23; Lotta Viikari, *The Environmental Element in Space Law, Assessing the Present and Charting the Future* (Martinus Nijhoff, 2008) at 32.

[4] Firooz Allahdadi, Isabelle Rongier, Paul D. Wilde**,** *Safety Design for Space Operation***s** (Elsevier, 2013) at 17.

[5] ESA, 'Space debris by the numbers' available at http://www.esa.int/Our_Activities/Operations/Space_Debris/Space_debris_by_the_numbers accessed 3/11/2017.

[6] IADC Space Debris Mitigation Guidelines (2002) available at http://www.iadc-online.org/Documents/IADC-2002-01,%20IADC%20Space%20Debris%20Guidelines,%20Revision%201.pdf.

Uses of Outer Space (UNCOPUOS) that, in 2007, adopted Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space.[7]

The UN COPUOS Space Debris Mitigation Guidelines are:

1. Limit debris released during normal operations
2. Minimize the potential for break-ups during operational phases
3. Limit the probability of accidental collision in orbit
4. Avoid intentional destruction and other harmful activities
5. Minimize the potential for post-mission break-ups resulting from stored energy
6. Limit the long-term presence of spacecraft and launch vehicle orbital stages in the Low Earth orbit (LEO) region after the end of their mission
7. Limit the long-term interference of spacecraft and launch vehicle orbital stages with the Geosynchronous Earth Orbit (GEO) region after the end of their mission

Whilst these non-binding guidelines constitute "the leading international arrangement to mitigate space debris",[8] they are often seen as inapt to tackle the overall issue of space debris. Unfortunately, the 25 years-rule set out by the "IADC Space Debris Mitigation Guidelines" as the lifetime limit of space objects after which to undertake a controlled re-entry in the atmosphere is not expressly repeated. Environmental protection is not even mentioned, and the intentional destruction of space objects is not totally banned.[9] The inadequacy of this method is not related to these issues or to the voluntary nature of these measures but, especially, to the technical consideration that, even if the creation of all new space debris were to stop now, the problem would not be solved. Indeed, it is generally accepted that portions of the region of the Low Earth Orbit (LEO) are already environmentally unstable, as the population of space debris is large enough to potentially trigger a cascade of collisions leading to the production of new orbital debris (the so-called Kessler effect).[10]

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[7] Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, as annexed to UN doc. A/62/20 (2007).

[8] Towards Long-term Sustainability of Space Activities: Overcoming the Challenges of Space Debris, A Report of the International Interdisciplinary Congress on Space Debris, January 2011, UN doc. A/AC.105/C.1/2011/CRP.14, at 5.

[9] According to Guideline 4 "intentional break-ups" could be "necessary", in this case "they should be conducted at sufficiently low altitudes to limit the orbital lifetime of resulting fragments". Space Debris Mitigation Guidelines (n.7).

[10] Joseph N. Pelton, *Space Debris and Other Threats from Outer Space* (Springer, 2013) p. 2; Firooz Allahdadi, Isabelle Rongier, Paul D. Wilde (n.4) at 18,576; "The term "Kessler Syndrome" is an orbital debris term (…) that grew out of a 1978 JGR paper predicting that fragments from random collisions between catalogued objects in low Earth orbit would become an important source of small debris beginning in about the year 2000 (…) While popular use of the term may have exaggerated and distorted the conclusions of the 1978 paper, the results of all research to date confirms that we are now entering a time when the orbital debris environment will increasingly be controlled by random collisions." Donald J. Kessler, Nicholas L. Johnson, J.-C. Liou, Mark Matney 'The Kessler Syndrome: Implications to Future Space operations' (33rd annual AAS guidance and control conference, Breckenridge, Colorado, February 6–February 10 2010) at 1, available at

In the light of the above, the second approach normally advanced to cope with the issue of space debris focuses on active debris removal (ADR) and orbital satellite services (OSS). This approach takes its momentum from the growing consensus that, in the light of previous considerations, these activities are the only ones that may ensure long-term sustainability of outer space exploration and use.[11] These measures aim to reduce the existing amount of space debris through different techniques.

(1) *Active debris removal* refers to any action directed to remove a defunct spacecraft, vehicle or space object from Earth orbit. This include a wide range of activities, for example: the utilization of thrusters or passive de-orbiting systems to increase the atmospheric drag at the end of life of a space system as well as for the upper stage of a launcher vehicle; the employment of some form of directed energy device to change the orbit of a space object; sending a space-system to outer space that can directly or indirectly change the orbit of the targeted space object.[12]
(2) *Orbital satellite services* (OSS) are conceived in the broad context of ADR measures. In particular, OSS take account of technologies carried out by robotic devices to extend the lifetime of functional satellites. The same technology could be used to reduce the orbital debris population by modifying, recycling, upgrading a defunct space object or attaching it to other space objects, forming a useful sub-system or a complete functional satellite.[13] In this last regard, Project Phoenix of the Defense Advanced Research Projects Agency (DARPA) aims to develop robotic satellite servicing and assembly technologies capable of recycling components of space objects that are still intact, and forming functional satellites.[14] Also, the European Space Agency (ESA) is involved in space debris remediation technologies, in particular the first European system for Active Debris Removal with Nets (ADR1EN) testing net technologies on the ground with the aim of commercialising them later on.[15]

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http://webpages.charter.net/dkessler/files/Kessler%20Syndrome-AAS%20Paper.pdf accessed 21/10/2017.

[11] Lotta Viikari, 'Environmental aspects of space activities' in Frans vor den Dunk, Fabio Tronchetti (eds.), *Handbook of Space Law* (Edward Elgar, 2015) p. 757; Active Debris Removal-An Essential Mechanism for Ensuring the Safety and Sustainability of Outer Space, A Report of the International Interdisciplinary Congress on Space Debris Remediation and On-Orbit Satellite Servicing, 27 January 2012, U.N. Doc. A/AC.105/C.1/2012/CRP.16, pp. 8–15; Firooz Allahdadi, Isabelle Rongier, Paul D. Wilde (n.4) p. 18: Pelton (n.1) at 7.

[12] Pelton (n.1) at 8.

[13] Ibid.

[14] C. G. Henshaw, 'The DARPA Phoenix Spacecraft Servicing Program: Overview and Plans for Risk Reduction', Proceedings of 12th International Symposium on Artificial Intelligence, Robotics and Automation in Space (Montreal, Canada, 2014); Active Debris Removal (n.11) at 27.

[15] Jason L. Forshaw, Guglielmo S. Aglietti, Thierry Salmon, et al, 'Final payload test results for the Remove Debris active debris removal mission' (2017) 138 Acta Astronautica 326; See also Hrishik Mishra and Phillip Schmid, 'Motion And Parameter Estimation For The Robotic Capture Of A Non-Cooperative Space Target Considering Egomotion Uncertainty' (Symposium on Advanced

For the purpose of this analysis, ADR technologies include the notion of OOS as a means of conducting removal operations.

As will be later discussed, even if the technologies to achieve these goals are currently in an advanced stage, their use meets significant legal and political obstacles. One of the main concerns could be the interplay between the use of these technologies and the weaponization of outer space. Taking this into account, this contribution will move from the current legal framework and the main legal issues related to space debris removal activities, to eventually focus on the above-mentioned interplay.

4.1.2 The Corpus Juris Spatialis and Space Debris, an Unforeseen Challenge?

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (hereinafter also Outer Space Treaty)[16] constitutes the basic legal framework of international space law and has been ratified by 106 states and signed by 25 signatories.[17] It is considered as a quasi-constitutional treaty. Furthermore, it is also generally agreed that the principles of the earlier Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space[18] (which were mostly incorporated into the Outer Space Treaty) express general customary law, binding on all states.[19]

At the time the Outer Space Treaty was drafted, the space debris issue was not seen as a long term threat to space access and space activities, and, as a conse-

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Space Technologies in Robotics and Automation ASTRA, 20–22 June 2017, Leiden) asserting "The Deutsche Orbitale Servicing Mission (DEOS) from German Aerospace Center (DLR) was considered pivotal in steering the narrative in On-Orbit Servicing (OO-Servicing) towards capture of a non-cooperative spacecraft as a mission objective to secure and de-orbit uncontrollable satellites".

[16] Adopted on 19 December 1966, opened for signature on 27 January 1967, in Washington, Moscow and London, entered into force on 10 October 1967, 610 UNTS 205.

[17] Status of International Agreements Relating to Activities in Outer Space as at 1 January 2017, U.N. doc. A/AC.105/C.2/2017/CRP.7, available at http://www.unoosa.org/documents/pdf/spacelaw/treatystatus/AC105_C2_2017_CRP07E.pdf. Accessed 03/11/2017.

[18] Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, GA Res. 1962(XVIII) [hereinafter Declaration].

[19] "(…) the provisions of the Principles Declaration are virtually identical to their equivalents in the Outer Space Treaty, it is probable they can all be considered to have crystallised into customary law." Ricky J. Lee, Steven R. Freeland, 'The Crystallisation of General Assembly Space Declarations into Customary International Law' (54th International Astronautical Congress of the International Astronautical Federation, the International Academy of Astronautics, and the International Institute of Space Law 29 September–3 October 2003, Bremen, Germany); J. I. Gabrynowicz, 'The Outer Space Treaty and enhancing space security', UNIDIR, Building the Architecture for Sustainable Space Security: Conference Report 30–31 March 2006, at 113.

quence, no specific provision was included therein. The same applies to other international agreements concerning outer space, which were later adopted.[20] International space law was not constructed to directly deal with this issue[21]; neither the Outer Space Treaty nor the other four agreements composing the so-called *Corpus juris spatialis* contain an *ad hoc* regulatory regime of space debris or a legal regime concerning the protection of the outer space environment itself.

That said, even if the text of the relevant provisions does not refer to orbital debris, it would be inaccurate to rely solely on a literal interpretation to address the problem.

By contrast, the Outer Space Treaty is primarily a treaty of principles, since many Articles of the Treaty are articulations or copies of the Declaration provisions. As a result, the norms of the Outer Space Treaty cannot embody exclusively in their text a clear legal regime for any forthcoming issue affecting the whole outer space scenario. Though, bearing in mind the assumption that one of the duties of the interpreter is the action of researching and clarifying the rule that in the silence and ambiguity of the text should be applied,[22] the relevant norms of the Outer Space Treaty and the other agreements on outer space seems to fall into an inextricable legal impasse in addressing the question of space debris, making the search for a possible solution far more complex for the interpreter.

Indeed, as was correctly observed: "remediation of space debris meets its first major obstacle in the perplexing legal regime".[23] Even if ADR and OOS operations are imperative,[24] the provisions of the Outer Space Treaty and the other agreements on outer space, far from incentivising space debris remediation, pose various legal problems, many of which needed to be solved before conducting any removal operation.

4.1.3 The Outer Space Treaty and Space Debris: A Protective Legal Cradle

There is no provision in the *Corpus juris spatialis* that addresses the matter of space debris; instead the treaties use the term 'space object'. Thus, only inferential conclusions can be drawn from the legal regime with respect to space debris and space

[20] Convention on International Liability for Damage Caused by Space objects, 29 March 1972, 961 UNTS 187 (hereinafter Liability Convention); Convention on Registration of Objects Launched into Outer Space, 29 November 1971, UNGA Res. 3235 (XXIX) (hereinafter the Registration Convention); Agreement on the Rescue of Astronauts and the Return of Objects Launched in Outer Space, 22 April 1968, 672 UNTS 119; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 18 December 1979, 1363 UNTS 3.

[21] Active Debris Removal (n.11) at 33.

[22] Boleslaw Adam Boczek, *International Law: A Dictionary* (The Scarecrow Press, 2005) at 328.

[23] Joshua Tallis, 'Remediating Space Debris, Legal and Technical Barriers' (2015) 9(1) Strategic Studies Quarterly 86.

[24] Lotta Viikari, 'Environmental aspects of space activities' (n.11) at 757.

debris remediation. A broad interpretation of the term 'space object' could arguably include 'space debris', considering that both space objects at the end of their lifetime and orbital fragments of the same are space debris.

Although the goal of this analysis does not extend to the analysis of this specific issue, it is anyhow important to point out that if space debris does not qualify as a space object, the entire issue would then fall mostly outside the scope of application of the outer space treaties.[25]

Bearing this in mind, Article VIII of the Outer Space Treaty is the most relevant norm and shall be regarded as the core of the legal framework when it comes to space debris removal, as it contains the fundamental legal terms of other norms applying to space debris and thus space debris remediation.

The first part of Article VIII of the Outer Space Treaty provides:

> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body.

The second part of Article VIII points out:

> Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

Outer space is a sovereignty-free area in which registration creates a chain of attributions between the space object and the registering State. These attributions consist of: *jurisdiction and control over the space object*; *ownership*; *international responsibility for national space activities*; *liability of all launching States*.[26] These principles represent fundamental elements of international space law, since they were firstly stated in the Declaration and then embodied in the Outer Space Treaty.

The jurisdiction and control clause is in the first sentence of Article VIII, indeed the registering State "shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body". In this context article II(2) of the Registration Convention is particularly relevant: "Where there are two or more launching States in respect of any such space object, they shall jointly determine which one of them shall register the object". It follows that jurisdiction and control over a space object will exclusively be executed by the registering State.

This consists "[of] the power of the state under international law to regulate or otherwise impact upon people, property and circumstances and reflects the basic

[25] Lotta Viikari, *The Environmental Element in Space Law, Assessing the Present and Charting the Future* (n.3) at 70–71; Marietta Benko, et al., *Space Law: Current Problems and Perspectives for Future Regulation* (Eleven International Publishing, 2005) at 41–42.

[26] Stephan Hobe, et al., *Cologne Commentary on Space Law*, vol.1 (Carl Heymanns Verlag, 2009) at 495.

principles of state sovereignty, equality of states and non-interference in domestic affairs."[27]

In accordance with this set of provisions, the jurisdiction and control clause seems to be an impediment to ADR operations, since it covers space objects in a quasi-territorial manner, allowing the State of registry to subject its space assets and personnel to any national laws that are not in conflict with international law.[28] The event of a removal operation unilaterally carried out by a third State would constitute a violation of the Outer Space Treaty.

Indeed, jurisdiction over a space object or parts and fragments of the same does not expire for the sole practical reason that the registering State has lost the control over such objects. Determinating whether a space object is 'uncontrolled' or 'non-functional' may be more complex than expected. While other states might perceive a space object as totally useless, it could in reality still have some value. An inactive space object may, for instance, be in reserve for future activities, carry valuable classified information, or be of some other interest unknown to other states.[29]

This is even more relevant when considering the *ownership* of space objects.

Ownership of a space object is a determining factor in identifying which state can exercise jurisdiction and control. Since Article VIII does not define the "owner" of the space object, it is important to note that the registration of space object serves as an element for identification in the sense of national ownership.[30] The State of registry has been defined in the Registration Convention as a launching state on whose registry a space object is carried—it follows that the state owner, therefore, has to be a state that launches or procures the launching of a space object or a state from whose territory or facility a space object is launched.[31]

Ownership of space objects is perpetual, indeed it "is not affected by their presence in outer space or on a celestial body or by their return to the Earth." This is particularly important since even if a state has lost *de facto* control over the space object, or the space object has been reduced to hundreds of space debris, ownership continues irrespective of where the object may be, and of the functional or material status of the same object.[32] *A fortiori*, non-functional or uncontrolled space objects

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[27] Micheal N. Shaw, *International Law* (8th edn, Cambridge University Press, 2017) at 483.

[28] Gbenga Oduntan, *Sovereignty and Jurisdiction in Airspace and Outer Space: Legal Criteria for Spatial Delimitation* (Routledge, 2012) at 180; Fabio Tronchetti, *The Exploitation of Natural Resources of the Moon and Other Celestial Bodies: a proposal for a legal regime* (Martinus Nijhoff, 2009) at 202.

[29] Lotta Viikari, *The Environmental Element in Space Law, Assessing the Present and Charting the Future* (n.3) at 33.

[30] Ogunsola O. Ogunbanwo, *International law and outer space activities* (Martinus Nijhoff, 1975) at 82.

[31] Joyeeta Chatterjee, *Legal Issues Relating To Unauthorised Space Debris Remediation* (65th International Astronautical Congress, Toronto, Canada, 2014) at 7.

[32] Active Debris Removal (n.11) at 31; Joshua Tallis (n.23) at 91; Lotta Viikari, *The Environmental Element in Space Law, Assessing the Present and Charting the Future* (n.3) at 82.

cannot be abandoned at the end of their lifetime.[33] This means that regardless of whether the registering state has lost the control over an entire space object or small fragments of the same, ownership is not affected in any manner, tying the State of registry to bearing international responsibility and liability for any damage caused by its space object, even though it is no longer controllable.

The Outer Space Treaty establishes the comprehensive liability of all launching states. Based on Article VII: "each State Party to the Treaty (…) that launches or procure the launch of an object into outer space including the Moon or other celestial bodies" and "each State Party from whose territory of facility the object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies." This provision is particularly important as extends the liability for damage caused by an object or its component part, and applies to damage occurring anywhere: on Earth, in the air, or in outer space.[34]

The Liability Convention complements these provisions by setting out more detailed rules for cases of 'space damage' involving different states. In fact, the Liability Convention establishes two separate regimes of liability: one of absolute liability, to be applied in the case of damage caused by a space object "on the surface of the Earth or to aircraft flight", and another based on fault liability which applies when the damage occurs in outer space.[35]

That said, with respect to ADR operations these regimes are only relevant on the occurrence of damage, originating from a removal operation, suffered by states or legal or juridical persons due to the space activities of others. The only compensable damage is that which results in "loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations". Leaving aside the complexity of the concept of 'fault' when the damage occurs in outer space, the Liability Convention excludes any damage to the outer space environment itself, and does not take into concern an obligation to carry out a removal operation under the circumstance of damage occurring in outer space. Currently, space debris are beneficiaries of the provisions of the outer space legal regime drafted to protect

[33] Lyall and Larsen, *Space Law: A Treatise* (Routledge, 2016) at 84; Ram S. Jakhu, Joseph N. Pelton, *Global Space Governance: An International Study* (Springer, 2017) at 123.

[34] Article VII of the Outer Space Treaty provides: "Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies."

[35] Lotta Viikari, *The Environmental Element in Space Law, Assessing the Present and Charting the Future* (n.3) at 65.

space objects and ensure peaceful outer space activities,[36] erecting legal barriers to any attempt at removal or changing the orbit of space objects.

As will be later discussed, ADR operations would be more effective if not bounded by any 'fault-based' legal regime. Indeed, the implications of active debris remediation measures shall be firstly addressed with regard to the fundamental legal criterion of the protection of the outer space environment and the freedom of access to outer space.[37]

From the above discussion it is apparent that on the one hand, international space law is silent about space debris and space debris removal operations. On the other hand, the occurrence of a removal operation carried out by a state not owner of the removed debris, would constitute an internationally wrongful act, since the registering State retains jurisdiction and control and ownership of the space object even if it is blown up into thousands of debris.

At least one legal mechanism could be useful for a removal operation of space debris—this is the prior consent of the state owner. Prior consent to the removal operation would remove the wrongfulness of the conduct.[38] However, this legal mechanism could be regarded as a 'too late and too slow approach' in dealing with space debris. Comprehensive cleaning operations of Earth's orbit are now a necessity, and prior consent requires a prior identification of the space debris, which is not always possible.[39] A system based on multiple authorizations for ADR operations would not be suitable to face the problem in view of the large-scale removal operation needed, especially in LEO and in the Geostationary Earth Orbit (GSO). Thus, authorization could be a source of international disputes when a removal measure exceeds the limits of the consent given,[40] or in case of damage to a space object caused by the same removal operation, with the possible creation of new space debris.[41]

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[36] Benko (n.25) at 43.

[37] The second sentence of Article I of the Outer Space Treaty provides: "Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies."

[38] International Law Commission, "Draft Articles on Responsibility of States for Internationally Wrongful Acts" Official records of the General Assembly, 56th Sess., Supp. no. 10 (A/56/10); International Law Commission, *Yearbook Of The International Law Commission*, vol. II pt.2 (Report of the Commission to the General Assembly on the work of its fifty-third session, 2001) U.N. Doc. A/CN.4/SER.A/2001/Add.1 (Part 2) at 72–74.

[39] Firooz Allahdadi, Isabelle Rongier, Paul D. Wilde (n.4) at 583; Lotta Viikari, *The Environmental Element in Space Law, Assessing the Present and Charting the Future* (n.3) at 36.

[40] International Law Commission, *Yearbook Of The International Law Commission* (n.38) at 74.

[41] To avoid these issues, some authors even suggest "[that] future regulatory mechanisms for debris removal could even require that space debris be declared to be under no one's "jurisdiction and control"; otherwise removal mechanisms not capable of distinguishing between different kinds of objects could end up being in violation of the UN space law" Lotta Viikari, *The Environmental Element in Space Law, Assessing the Present and Charting the Future* (n.3) at 83.

4.1.4 Space Weaponization and Active Debris Removal: A Comprehensive Legal Perspective

The legal status of space debris provided by the outer space legal regime is one of the major legal obstacles to active debris removal operations. In fact, the main legal path with which to deal with space debris removal is centered on Article VIII of the Outer Space Treaty. The *ownership* clause and the *jurisdiction and control* clause seem to exclude any effort regarding lawful ADR in Earth orbits.

Although this legal approach may be considered a cornerstone regarding the status of space debris in the current legal framework, it is not be the most appropriate when it comes to ADR operations.

An environmental perspective on outer space could underpin the circumstances under which rightful removal operations may be conducted. Indeed, ADR technologies may, first, be linked to one of the fundamental issues that led to the international consensus underlying the draft of the Outer Space Treaty: freedom of access and exploration of outer space by all states.

This implies that outer space should be a peaceful environment in the sense of a broad non-harmful medium for space activities. Second, ADR technologies are linked to the protection of the outer space environment, and in the present time, to the imperative necessity to remediate space debris, assuring sustainable access and use of outer space. As has already been mentioned above, the outer space environment has little capacity to cleanse itself. Space activities generating space debris will produce an immediate and potentially permanent negative impact on the outer space environment.[42]

The issues "*outer space should be a peaceful environment in the sense of a broad non-harmful medium for space activities"* and "*protection and remediation of outer space environment*" in order to achieve "*the freedom of access and exploration of outer space by all States*" are linked to ADR technologies but also to the legal implications of space weaponization. The will to avoid unrestrained weaponization of outer space could be considered another part of that international consensus which led to the elaboration of the Declaration and further of the Outer Space Treaty.

In fact, the Outer Space Treaty was an essential tool to avoid that states use weapons in outer space (especially in the cold war context), and to ensure freedom of access and exploration of outer space by all states, and peaceful space activities, a crucial objective pursued by the international community that would be drastically compromised by the possibility of putting weapons in space. In addition, space weaponization is a threat to the outer space environment, constituting the easiest way to make outer space a battlefield and a consequential source of space debris. That said, outer space as a "*peaceful environment in the sense of a*

[42] SpaceSecurity.org, Space Security 2008, at 25 noting that "debris in orbits above 600 kilometers will remain a threat for decades and even centuries." available at http://spacesecurityindex.org/wp-content/uploads/2014/10/SSI2008.pdf.

broad non-harmful medium for space activities" would be undermined by space weaponization.

From this discussion, it may be argued that ADR technologies and space weaponization are linked both legally and factually, both connected to the essential issues around which international consensus on the draft of the Outer Space Treaty was formed.

This interrelation implies that a unique approach is needed, as conceding something to one side will inevitably impact on the other side. As was correctly observed: "circumventing the provisions of the existing regime that establish jurisdiction and control in the State of registry may have negative consequences for space security".[43] Indeed a spacecraft capable of grabbing space debris could also be used to damage or disrupt a functional satellite.

A comprehensive environmental perspective as described above, seems to address the problem of space debris at its core: the lawfulness of ADR operations, as the starting point from which detailed regulation is elaborated.

In this regard, Article I and Article IX of the Outer Space Treaty are particularly relevant, since they relate to the essential premise regarding outer space as a "*peaceful environment in the sense of a broad non-harmful medium for space activities"*.

Article I of the Outer Space Treaty establishes fundamental principles which, in one way or another, affect all state activities in outer space, and could be considered as part of international customary law.[44] This last assumption is particularly relevant as regards Article 1, since the vagueness of its terms make its practical application a problematic issue. Article 1 of the Outer Space Treaty provides:

> The exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind. Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies. There shall be freedom of scientific investigation in outer space, including the Moon and other celestial bodies, and States shall facilitate and encourage international cooperation in such investigation.

Article I (2) grant three basic rights to all spacefaring states: the right of free access, the right of free exploration, and the right of free use. In addition, it establishes a parameter regarding the exercise of these three rights, indeed access to outer space and exploration and use of outer space shall be carried out "without discrimination of any kind" and "on a basis of equality". No state can be prevented from exercising these rights and in case another state party does so, it will commit a violation of the Treaty.[45]

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[43] Active Debris Removal (n.11).

[44] Fabio Tronchetti (n.28) at 24–25; See also Ricky J. Lee, Steven R. Freeland (n.19).

[45] Ibid.

In this context, Article IX of the Outer Space Treaty is relevant since it points out an invaluable regulation regarding outer space activities and the outer space environment.

In fact, Article IX (1) sets out the general principle, according to which, in the exploration and use of outer space "States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance (…) with due regard to the corresponding interests of all other States". Article IX (2) significantly adds "States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth" and adopt measures for this purpose. Article IX (3) contains a mandatory international consultation clause in that if a "State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space (…) would cause potentially harmful interference with activities of other States Parties" or "a State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space (…) would cause potentially harmful interference with activities in the peaceful exploration and use of outer space", then a state "may request consultations concerning the activity or experiment."

The legal framework provided by Article I and Article IX lays down what could be considered as the cardinal points of the legal relation between ADR operations and the assumption of outer space as a "*peaceful environment in the sense of a broad non-harmful medium"*. The following principles are relevant:

(1) *Freedom of access, use and exploration of outer space by all states without any discrimination and on a base of equality*;
(2) *Prohibition of harmful contamination of outer space and harmful interference of outer space activities;*
(3) *Adoption of appropriate measures to avoid environmental contamination of outer space and interference between space activities*;
(4) *Mandatory international consultation in case of a potentially harmful interference with activities in the peaceful exploration and use of outer space;*

It could be argued that ADR technology acts as a fundamental tool in order to make these principles work in practice. These technologies could be considered as the standard response in the remediation of an environmental danger to outer space itself, and to outer space activities capable of jeopardizing the above principles.

In the high-crowded orbit regions, these principles assume great value within the legal framework of the Outer Space Treaty and could constitute the legal basis for ADR operations. Indeed, the progressive congestion of outer space due to the increasing debris population is moving the outer space environment towards the threshold of an irreversible situation.[46] That said, an environmental approach to

[46] "the current environment [of LEO] is already above a critical density, even 100% compliance with these [Space Debris Mitigation] guidelines would not prevent the debris environment from increasing." Donald J. Kessler, Nicholas L. Johnson, J.-C. Liou, Mark Matney (n.10) at 12–13.

space debris and ADR operations should be considered as the main method to address the problem.

However, with this scenario in mind, the essential question cannot be avoided: what can be done with the existing legal regime?

Before assessing workable legal solutions, space weaponization should be briefly taken into account, since it might constitute the other side of the coin within the ADR context. Tested ADR technologies are based on the creation of the capability to locate, intercept and capture space debris, such as robotic arms, net technologies, and electrodynamic tethers.[47] Those same capabilities apply to space weapons, assessing the dual-use nature of ADR technologies. Any spacecraft capable of carrying out a removal operation could also be used for military purposes, such as the capture or the manipulation of satellites in an attempt to deny linkage to outer space to a potential adversary.

Outer space is indeed a highly militarized environment. Due to its unique features, outer space offers crucial advantages to those waging war. For example, space offers persistency of coverage—space objects move at extremely high speed because of orbital mechanics and there is no point on the earth's surface or in the airspace that cannot be observed from outer space. Space-based systems enable precision navigation and positioning, provide real-time weather data, make possible instantaneous global communications, and conduct surveillance and reconnaissance missions.[48] Militaries with developed space-capabilities are strongly dependent on space assets, to the point that without reliable satellites in orbit, most of their capacities would be deteriorated.

Moreover, most space assets, such as communications, weather forecasting and observation satellites, may be exploited for both military and non-military purposes. Accordingly, civilian and military satellites have become deeply intertwined.

As has been observed: "Space today from a military perspective is fundamental to every single military operation that occurs on the planet today […] Every operation from humanitarian operations to major combat operations is critically dependent on space capabilities".[49]

States largely exploit outer space for passive military uses, such as satellite positioning, communication, and reconnaissance. These activities are part of the so-

[47] Active Debris Removal (n.11) at 24–28.

[48] M. N. Schmitt, 'International Law and Military Operations in Space' in A. von Bogdandy, R. Wolfrum (eds.) Max Planck Yearbook of United Nations Law (vol. 10, 2006, Brill Academic Publishers) at 90–94.

[49] Air Force Gen. John E. Hyten, commander of the United States Strategic Command, 'U.S. Strategic Command Perspectives on Deterrence and Assurance' (Speech at the Stanford University's Center for International Security and Cooperation, California, 24 January 2017) available at http://cisac.fsi.stanford.edu/sites/default/files/transcript_stratcom_-_hyten_160125_no_qa.pdf; see also Michael Krepon & Christopher Clary, *Space Assurance or Space Dominance? The Case Against Weaponizing Space* (Henry L. Stimson Center, 2003) at 10–27 (asserting that "Today, space assets play a much larger role in the real-time enhancement of military operations" and describing satellite's contributions to military navigation, remote sensing, communications, and weaponry).

called militarization of space, which encompasses every use of space in which space-systems are not part of a direct engagement in warfare but are confined to the support of combatants. Due to the perceived non-aggressive nature of these activities, the militarization of outer space has been broadly accepted by the international community as not being contrary to Article 2(4) of the United Nations Charter.[50] Nevertheless, it is questionable whether every passive military utilization of outer space is also non-aggressive, such as the use of satellites to direct bombing raids.

On the other side, the weaponization of space, or active military use of outer space, has been described as "the deployment of weapons of an offensive nature in outer space or on the ground with their intended target located in space".[51] During the cold war both the United States of America (USA) and the Union of Soviet Socialist Republics (USSR) developed the capacity to destroy satellites through anti-satellite weapons (ASAT). Today, with the current pace of diffusion of technology, many more countries have demonstrated ASAT capabilities.[52] The utilization and risk of proliferation of these weapons are major critical issues regarding outer space activities. Although outer space is currently not weaponized,[53] the idea of conducting defensive and offensive operations in outer space has been embraced by the military doctrines of the major space-powers.[54] The growing threat of the weaponization of space is strictly linked with space debris and the deterioration of the outer space environment.

Indeed, ASAT weapons are essentially divided into kinetic energy weapons and directed energy weapons. Kinetic energy weapons achieve their destructive effect through direct collision or near-explosion with the target. The large majority of ASATs are kinetic weapons, such as standard missiles, small projectiles propelled by electromagnetic canons, and 'killer satellites' that co-orbit and destroy the tar-

[50] Art.2 (4) of the United Nations Charter provides as follows: "All Members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state, or in any other manner inconsistent with the Purposes of the United Nations." United Nations, Charter of the United Nations, 24 October 1945, 1 UNTS XVI.

[51] Fabio Tronchetti 'A Soft Law Approach to Prevent the Weaponisation of Outer Space' in Irmgard Marboe (ed) Soft Law in Outer Space: The Function of Non-binding Norms in International Space Law (Böhlau Verlag 2012) 361–386.

[52] "China, Russia and the United States all possess these capabilities. India's recent development of a layered missile defence system indicates it is likely to have the capability (at least in the near-term) of direct-ascent ASAT capabilities. Japan, Israel, and France can also be considered turn-key ASAT players in today's international space defence environment, as they are currently only barred from entry by the political will to do so, rather than by technological capabilities" NATO Parliamentary Assembly (n.2) at 6.

[53] Unidir, *Outer Space and Global Security* (Unidir/2003/26) at 15; John Kierulf, *Disarmament under International Law* (McGill-Queen's University Press, 2017) at 154; Adam G. Quinn, 'The New Age of Space Law: The Outer Space Treaty and the Weaponization of Space' (2008) 17 Minn. J. Int'l L. 475, 494.

[54] Steven Freeland, Jackson Maogoto, 'Space Weaponization and the United Nations Charter Regime on Force: a Thick Legal Fog or a Receding Mist?' (2007) 41(4) The International Lawyer 1091.

get.[55] Alternatively, ASAT weapons may be directed energy weapons, which damage or destroy the target through a direct emission of energy.[56] These technologies include, for example, high-energy lasers, particle beam cannons, and electromagnetic pulses created by a nuclear explosion in space or by a non-nuclear electromagnetic bomb (E-BOMB).[57] These weapons could temporarily degrade a satellite sub-system or permanently damage a spacecraft, without relying on physical projectiles.

One major feature that distinguishes ASAT weapons is the creation of space debris. As mentioned above, only kinetic ASATs destroy the target physically by colliding with it, thus generating thousands of space debris.

Even if no hostile use of ASATs has been recorded,[58] states have rarely raised any objection under international law to the development and testing of these technologies. For example, when China tested an ASAT weapon in January 2007, producing approximately 20% of the entire currently catalogued debris,[59] a spokesperson for the United Kingdom was reported to have said: "We are concerned about the impact of debris in space and we expressed that concern […] We don't believe that this does contravene international law."[60]

Article IV of the Outer Space Treaty directly addresses the matter of space militarization and weaponization, establishing only a partial demilitarization of outer space, as follows:

> States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner. The Moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the Moon and other celestial bodies shall also not be prohibited.

States parties to the OST are forbidden to place, install or station nuclear weapons or weapons of mass destruction in outer space in any manner. The placement or the utilization of anti-satellite weapons is not forbidden.[61] In addition, in the debate

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[55] Detlew Wolter, *Common Security in Outer Space and International Law* (UNIDIR 2005) [emphasis added] at 34–37.

[56] Bahman Zohuri, *Directed Energy Weapons: Physics of High Energy Lasers (HEL)* (Springer, 2016) at 81 [emphasis added].

[57] Detlew Wolter (n.55); CARLO KOPP, 'The E-Bomb: A Weapon Of Electrical Mass Destruction' Proceedings Of Infowarcon V, Washington, DC, September 1996.

[58] SpaceSecurity.org, Space Security 2014, at 7. Available at http://spacesecurityindex.org/wp-content/uploads/2014/11/Space-Security-Index-2014.pdf.

[59] Ibid.

[60] Pavle Kilibarda, 'The Militarization of Outer Space and Liability Convention' (2015) 40(3) Air and Space Law 271.

[61] Fabio Tronchetti, Fundamentals of Space Law and Policy (Springer, 2013) at 9; Johannes

over the significance of the 'peaceful purposes' clause as meaning either "non-military" or "non-aggressive", the "non-aggressive" use of outer space has prevailed and been endorsed by state practice.

The ambiguity of the legal framework of Article IV can be explained by the fact that both the United States and the Soviet Union had already launched satellites into outer space for military purposes at the time of the drafting of the Outer Space Treaty. During the cold war, space powers were extremely careful in ensuring that no provision of the treaty could infringe on their plans for the limited military uses of outer space.[62]

As a result, the legal gaps in Article IV have been filled by the advancement of military space technology towards the threshold of space weaponization. Nowadays, space assets are an integral part of the military hardware of the major powers, and willingness to refrain from the utilization of anti-satellite weapons in a potential conflict could be based on a thin legal and political balance.

The lack of legal clarity and good faith of space powers is increasingly putting outer space into a delicate situation. Dialogues over a binding treaty that might specifically address the problem are currently stalled.[63]

In this context, how does space weaponization relate to the set of four principles mentioned above?

The *Freedom of access, use and exploration of outer space by all States without any discrimination and on a base of equality* established by Article I of the Outer Space Treaty would be undermined by the deployment or use of space weapons, and the consequential growth of space debris could constitute a temporary or permanent impairment to access and exploitation of outer space for the whole international community. Indeed, a problem with a large-scale use of kinetic ASATs, is that even a sole impact can create a considerable amount of debris that can indiscriminately harm one's own satellites as well as those of others.[64]

In this context, the *prohibition of harmful contamination of outer space and harmful interference of outer space activities* is particularly relevant, since "harmful

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M. Wolff "Peaceful uses' of outer space has permitted its militarization: does it also mean its weaponization?' (2003) Disarmament Forum at 7.

[62] Paul G. Dembling, Daniel M. Arons 'The Evolution Of The Outer Space Treaty' (1967) 33 Journal Of Air Law And Commerce 419,433; Detlew Wolter (n.55) at 17.

[63] "The most recent attempt to achieve [a treaty concerning space weaponization] is the Russia/China Draft Treaty on the Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force against Outer Space Objects, submitted to the Conference on Disarmament in 2008 and 2014 […] Although the Draft Treaty may be regarded as a point of departure in the formulation of a treaty prohibiting the weaponisation of outer space, the criticism that has been raised by governments against the draft document makes it unlikely that it would be easily accepted by the majority of states […] In addition, there also seems to be still some concern regarding Russia and China's motives with the Draft Treaty, which are considered by some observers as an attempt to limit their adversaries' military capabilities". Anél Ferreira-Snyman 'Selected Legal Challenges Relating to the Military Use of Outer Space, with Specific Reference to Article IV of the Outer Space Treaty' (2015) 18(3) Potchefstroom Elec. L.J. 488.

[64] Ram S. Jakhu, Joseph N. Pelton, *Global Space Governance: An International Study* (n.33) at 274.

contamination of outer space" and "harmful interference with outer space activities of other state-parties" are supposed to be avoided in pursuing studies and exploration of outer space. The increasing congestion of Earth's orbits has led the two obligations, namely, to cause "no harmful contamination of outer space" and "no harmful interference with outer space activities of other state-parties", to assume a growing value in the legal framework of the Outer Space Treaty.

Article IX of the OST provides for the *adoption of appropriate measures to avoid environmental contamination of outer space and interference between space activities,* and *mandatory international consultation in case of a potentially harmful interference with activities in the peaceful exploration and use of outer space.* There is a lack of practical application of these provisions, mostly due to the space competition between the major space powers and the renewed attention to ASAT development.[65] In addition, states have not been willing to reveal too much about space activities, mainly because of the high geopolitical value of this kind of information.

That said, Article IX could be considered as the core of the future regulation of space activities since it is applicable to military and non-military space activities. As an inalienable condition of outer space exploitation itself, outer space activities must firstly take place in accordance with the obligations of "no harmful contamination of outer space" and "no harmful interference with outer space activities of other state-parties".

This approach does not exclude military uses of outer space, or an evolution of the same, if aligned with the legal parameters of Article IX, which should be regarded as a fundamental threshold of the lawfulness of each space activity.

Indeed, spacefaring nations have perceived the need to protect space assets given their nature as vulnerable and critical infrastructure. It could be argued that if space weaponization is in breach of international law and could be a definitive threat to space activities, by corollary, transparency and confidence-building measures in outer space activities could establish a different concept of 'space security'. These measures are being debated at international level and are an important opportunity to eliminate all miscommunications, misperceptions and apprehensions about potentially harmful activities in outer space.[66]

4.1.5 Selective Cleaning Operations: A Possible Temporary Solution?

A workable legal solution that would address ADR operations cannot avoid or minimize the issue of space weaponization. This must be considered as a crucial aspect of ADR technologies.

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[65] NATO Parliamentary Assembly (n.2) at 1.

[66] Transparency and confidence-building measures in outer space activities, Report of the Secretary-General, 16 February 2017, U.N. Doc. A/72/65.

The dual-use nature of ADR technologies bears different practical and legal consequences with respect to those posed by the current dual-use capacity of space assets.

For example, the utilization of civilian space assets, such as communication or observation satellites for military purposes, remains in the area of the passive military uses of outer space, which are generally accepted by the international community as permitted by Article 2(4) of the United Nations Charter, which basically prohibits "the threat or use of force".[67]

On the other hand, the deployment for military purposes of a satellite dedicated to removal operations would be an active military use of outer space, in the form of a space-based weapon, thus constituting that "threat or use of force" in outer space that the international community has been striving to avoid.

In September 2013, China carried out experiments in outer space regarding on-orbit servicing and satellite capture, involving a satellite fitted with a mechanical arm. These maneuvers raised international concerns that "the tests go beyond the stated objectives and are actually cover for testing on-orbit ASAT technology."[68] There is a thin line that separates ADR technologies from space-based weapons, and it could be argued that ignoring this feature in a possible future regulatory framework could lead to some sort of "masked weaponization" of outer space.

Bearing this in mind, what can be done with the existing legal regime? How can the set of four principles enshrined in Article I and Article IX of the Outer Space Treaty regulate ADR operations and ensure outer space as a "*peaceful environment in the sense of a broad non-harmful medium*"?

To answer these questions, a key-role should be played by the *mandatory international consultation in case of a potentially harmful interference with activities in the peaceful exploration and use of outer space,* which could deny access to outer space.

In effect, the increased accessibility of space technology has led to a deep diversification of space actors and space assets. As a result, outer space is increasingly becoming fundamental part of states infrastructures. Furthermore, the fundamental role of space-based assets in the essential fields of security, global communication and navigation, weather forecasting, and data transfer, weave the globe's highly complex $78 trillion economy together.[69] In the near future, access to and use of outer space could become increasingly exploitable by individuals. This prediction is substantiated by the development of commercial space flights and sub-orbital or orbital space tourism activities.[70]

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[67] Wolff (n.61) at 8.

[68] Space Security 2014 (n.58) at 78; Kevin Pollpeter 'China's Space Robotic Arm Programs' (2013) SITC Bulletin Analysis.

[69] NATO Parliamentary Assembly (n.2) at 1.

[70] OECD, The Space Economy at a Glance 2014 (2014, OECD publishing) at 64.

It could be argued that the principles laid down by Article I and Article IX have progressively assumed greater value as access to outer space has become essential to states, and even to individuals.

The mandatory international consultation clause in the event of 'harmful contamination of outer space' or 'harmful interference of outer space activities' could be the instrument to deal with space debris in the present time. This is even more important considering that collisional cascading, known as the Kessler Syndrome, could render some orbits unusable for centuries,[71] denying access, use, and exploration of outer space.

A discussion at international level would also minimize the threat of space weaponization, which would emerge eventual unilateral removal operations carried out by different states.

However, this matter will show all its complexity on the occurrence of broad international consultations concerning active debris removal. Which criteria for removal could be relevant?

In this respect, large-scale and small-scale removal operations bear different consequences and conclusions.

Large-scale removal operations will meet hard legal hurdles, requiring multiple authorizations by the states owners of the space objects, or at least multiple transfers of jurisdiction and control over the same objects to the entity or state that will conduct the removal. In addition, this approach may not be effective. In fact, not all debris are trackable, for each tracked debris there are 30–50 untracked objects in the centimeter range presenting a real danger to space assets.[72]

In pursuing this approach, attention would be concentrated on the removal of tracked and catalogued objects instead of addressing the uncatalogued "lethal population" of debris. Thus, in the discussion of large-scale removal, security issues need to be addressed, making harder the conclusion of an agreement.

On the other hand, small-scale removal and improved compliance with the IADC Space Debris Mitigation Guidelines, especially with the rule establishing a maximum of 25 years lifetime limit after which the space object should be re-entered in the atmosphere, could be effective and may constitute a first step toward a more general approach.

As has been demonstrated, complete compliance with the debris mitigation rules plus removal of five objects per year would prevent the number of catalogued fragments from increasing.[73] Broad international consultation in the event of 'harmful contamination of outer space' or 'harmful interference of outer space activities' posed by space debris could be the context in which states agree on this selective approach by removing a few objects per year.

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[71] C. M. Scaparotti, "Joint Publication 3–14, Space Operations," US Department of Defense, Joint Chiefs of Staff, Washington, D.C., 2013, at 9. Available at http://www.dtic.mil/doctrine/new_pubs/jp3_14.pdf.

[72] Firooz Allahdadi, Isabelle Rongier, Paul D. Wilde (n.4) at 583.

[73] Donald J. Kessler, Nicholas L. Johnson, J.-C. Liou, Mark Matney (n.10) at 13.

In the terms of Article IX, international consultations should be requested when a state "has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space" or when a state "has reason to believe that an activity or experiment planned by another State Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies".

Article IX is guided by principles of "cooperation and mutual assistance" with "due regard to the corresponding interests of all other States Parties to the Treaty". Even if Article IX has a lack of specificity and does not describe what constitutes "harmful interference" and does not designate an agency to which States should turn for this evaluation, the international consultation clause should be interpreted, ad minimum, as requiring contact with other States Parties to the Treaty whose peaceful explorations and use of outer space would experience potentially harmful interference.

This could be a 'step by step' method to reach agreement on the removal of a few objects per year and to construct a consensus for future agreement on comprehensive cleaning operations, targeting catalogued and uncatalogued objects, since the technology to achieve this objective could be soon available.[74]

4.2 Final Conclusions

Article VIII of the Outer Space Treaty assigns the jurisdiction, control and ownership of a space object to the state of registration for an indeterminate period of time, which militates against the unilateral removal of such an object by another entity. Some authors suggest exempting space debris from such 'protection' by space law.[75] This approach could raise serious security issues concerning space weaponization. A series of unilateral removal operations could transform the threat of weaponization of outer space into a reality.

The Outer Space Treaty and the other four agreements on outer space establish the essential rules regarding the access, use and exploration of outer space applicable to all space activities, independent of their military or non-military nature. It can be inferred from Article I and Article IX of the Outer Space Treaty that the

[74] Eugene Levin, Jerome Pearson, Joseph Carroll, 'Wholesale Debris Removal From Leo' (2012) 73 Acta Astronautica 100.

[75] "it has been suggested already several decades ago that the principles concerning jurisdiction and control of Article VIII of the OST balanced with those of Article IX regarding states' obligation to conduct their activities in outer space with due regard to the corresponding interests of other states would result in a qualified right to de-orbit inactive satellites" Lotta Viikari, *The Environmental Element in Space Law, Assessing the Present and Charting the Future* (n.3) at 82.

assumption that "*outer space as a peaceful environment in the sense of a broad non-harmful medium for space activities"* is a fundamental underlying issue in international space law. The legality of small-scale removal operations may be based on a broad interpretation of Article IX, and space actors should engage in international consultations in which a few space objects per year are targeted for de-orbit.

Nonetheless, a detailed future regulatory framework is needed especially for large-scale removal operations, since the Outer Space Treaty establishes only general rules that could be considered only as an initial step towards an instrument that directly addresses the removal of space debris. As has been correctly observed "[the Outer Space Treaty] is a quasi constitution, not only culmination, but also an initiation".[76]

In this last regard, the role of space weaponization should be specifically considered, since it is deeply intertwined with ADR technologies. In fact, the legal gaps of today could become the black holes of tomorrow—further legal uncertainty about space militarization and weaponization could make outer space a definitive arena of warfare.

However, it seems that a common understanding regarding the value of environmental protection of outer space and the need to assure long-term sustainability of outer space activities is currently growing. It has been estimated that "it appears that we are at the threshold of a new epoch in which environmental preservation of outer space has taken on a new meaning and sense of urgency not only for purposes of protecting valuable space assets in the short-term, but also to ensure the continued sustainability of space activities in the long-term".[77] The next step is for the international community, particularly space technologists, policy makers, and law makers, to make a concerted effort to find a workable legal framework, since ADR technologies have matured to the point of being able to provide low-cost solutions for wholesale LEO debris removal.[78]

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[76] George S. Robinson, Harold M. White, *Envoys of Mankind: A Declaration of First Principles for the Governance of Space Societies* (Smithsonian Institution Press, 1986) at 181.

[77] Active Debris Removal (n.11) at 8.

[78] Eugene Levin, Jerome Pearson, Joseph Carroll (n.74) at 16.

Chapter 5
The Right to (Anticipatory) Self-Defence in Outer Space to Reduce Space Debris

Annette Froehlich

Abstract Active debris removal is currently being widely discussed, because the simple mitigation of the creation of new space debris is no longer sufficient to guarantee the sustainable use of outer space. However, these discussions have encountered various difficulties due to the fact that the authors of the specialized UN space treaties, at the time of their drafting, did not take into consideration the many potential consequences of increased space activities, such as the problem of space debris, among others. The lack of clarity on how to handle this problem concerns not only the definition of space debris, but also the ways and means to address it, including the rights and obligations of involved operators.

In this setting, the EU initiative for an International Code of Conduct for Outer Space Activities is to be highlighted as an attempt at clarity in this domain, especially as it envisages the possibility of using the right of self-defence to avoid the creation of space debris. This right must be assessed in the context of existing international norms, such as the provisions of the UN Charter on the notion of self-defence. Its application in the frame of active space debris removal is being questioned by some Member States, and Russia is currently advocating holding a debate on self-defence in UNCOPUOS. Discussions and initiatives in the UN First Committee must also be taken into account as these are also seeking security and safety in outer space by examining the aspect of self-defence.

Analysis of the legal implications of active space debris removal requires understanding of the nature of the space debris problem. Since the launch of the first artificial satellite, SPUTNIK-I in October 1957 by the Soviet Union (USSR), more than 5250 launches have been undertaken. This has led to more than 42,000 tracked

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objects in orbit.[1] 23,000 of them remain in space and are regularly tracked by the US Space Surveillance Network,[2] the main source of information on space debris. This number dwarfs the approximately 1200 operational satellites that are currently in orbit.[3,4]

One example of an inoperable space object is the former Envisat ("Environmental Satellite") satellite of the European Space Agency (ESA), the world's largest civilian Earth observation satellite that is still in orbit (launch mass 8.211 kg). ESA formally announced the end of this Envisat mission on 9 May 2012 after an unexpected loss of contact with the satellite on 8 April 2012.[5] It has been calculated that it may need around 150 years to gradually decay through orbits to reach the Earth's atmosphere. While there are various projects and analyses to de-orbit this non-functional satellite, it nonetheless presents a collision risk.

Indeed, due to the cascade effect (Kessler syndrome), there is a high risk that space debris could generate an infinitely cascading number of further space debris. Various incidents in the past already underline the seriousness of the situation. The Chinese FengYun-1C engagement in January 2007 is one of these unfortunate operations that, alone, increased the trackable space object population by 25%.[6] Moreover, the first-ever in-orbit collision between two satellites on 10 February 2009 (the privately owned American communication satellite Iridium-33 and the Russian military satellite Kosmos 2251) must be noted. Their collision at 11.7 km/s led to their full destruction, which generated more than 2300 trackable fragments.[7] Due to the enormous speed of space debris, the International Space Station (ISS) and other satellite providers have frequently had to undertake avoidance manoeuvres to obviate any damage to the ISS and the humans aboard. In fact, functional space infrastructure has already been harmed by space debris, and space shuttle windows have had to be replaced because of damage from paint flecks.[8]

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[1] ESA, Space debris, http://www.esa.int/Our_Activities/Operations/Space_Debris/FAQ_Frequently_asked_questions.

[2] Their catalogue registers objects larger than 5–10 cm in low-Earth orbit (LEO) and 30 cm to 1 m at geostationary (GEO) altitude.

[3] ESA, About space debris, https://www.esa.int/Our_Activities/Operations/Space_Debris/About_space_debri; See also: Orbital Debris Quarterly News, https://www.orbitaldebris.jsc.nasa.gov/quarterly-news/newsletter.html.

[4] Total mass of all space objects in Earth orbit: About 7500 tonnes, figures provided by ESA's Space Debris Office at ESOC, http://www.esa.int/Our_Activities/Operations/Space_Debris/Space_debris_by_the_numbers.

[5] ESA, Earth Online, https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/envisat.

[6] ESA, About space debris, https://www.esa.int/Our_Activities/Operations/Space_Debris/About_space_debris.

[7] ESA, About space debris, https://www.esa.int/Our_Activities/Operations/Space_Debris/About_space_debris.

[8] NASA, Space Debris and Human Spacecraft, https://www.nasa.gov/mission_pages/station/news/orbital_debris.html.

Consequently, the question that arises is whether the doctrine of self-defence can be utilised to remove space debris in order to avoid or to reduce the risk for potential further incidents, especially as the protection of operating space objects and infrastructure is nowadays vital for the functioning of critical key-services of states.

Thus, in its draft for a Code of Conduct for Outer Space Activities, the European Union (EU) has explicitly employed the right to self-defence. Several other current initiatives along the same lines will also be analysed in the following. Also significant is that in several fora, such as the Committee on the Peaceful Uses of Outer Space (UNCOPUOS), the Russian delegation has foreshadowed discussion on the use of the right to self-defence in outer space in the context of active space debris.

Due to the amount of already existing space debris, the simple avoidance of the creation of new debris during the launching or operational phases is no longer sufficient to guarantee the sustainable use of space. Therefore, several issues need to be examined in the frame of active space debris removal. First, it is important to analyse the legal definition of space debris (Sect. 5.1). This will be followed by an in depth investigation of whether there is a right, or even an obligation, to remove space debris (Sect. 5.2) in the context of existing international legal norms to ensure peaceful behaviour in space (Sect. 5.3), but also in view of ongoing initiatives based on the right of self-defence to mitigate space debris (Sect. 5.4).

5.1 Legal Definition of Space Debris

Prevailing opinion considers any further human made objects in space to be space objects. However, the level of risk (for example of collision) emanating from space objects may be different, as functional space objects are manoeuvrable, which is mostly no longer the case for non-functional space objects and even less possible for space debris, especially non-trackable debris. Therefore, space debris has high risk potential as they seriously endanger all space activities. Consequently, regulation is needed, beginning with a legal definition of space debris.

5.1.1 Lack of Legal Clarity: Absence of Space Debris Definition

The legality of the removal of space debris is deeply affected by the lack of a legal definition of the term ‘space debris’. International space law (mostly based on the five United Nations space treaties and declarations) does not contain a definition of space debris. This gap leads to several ambiguities especially concerning the distinction between space debris and non-functional objects (the latter may be intentionally kept in space to serve as spares, or to be repaired when repair satellites can

be launched in orbit). In addition, the aspect of what is 'useful' is difficult to define as various actors may have different 'uses' in mind.[9]

Nevertheless reference can be made to Art. VII Outer Space Treaty (OST) which clearly stipulates that the launching state[10] "is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts (…)". In addition, the Convention on Registration of Objects Launched into Outer Space (REG) also lays down under Art. 1b REG that "the term 'space object' includes component parts of a space object as well as its launch vehicle and parts thereof".[11]

While the UN space treaties make clear that space objects include also their component parts, none of them see functionality as relevant in defining a space object. This is important because Art. VIII OST states that "a State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object". If the criterion of functionally were relevant for the classification of a space object, the state of registry would lose its right to exercise jurisdiction and control over a space object as soon as it became inoperable. This would contradict Art. VII OST that stipulates state liability for damages caused by its own space objects. If a state is liable for damages caused by its space objects, the state should have also the right to control and exercise jurisdiction over all operations affecting the space object, otherwise the link between the right to control the space operation and to assume responsibility and liability in case of damage would be interrupted.

5.1.2 Initiatives to Define Space Debris

Due to the lack of legal definition of space debris in the UN space treaties, various initiatives have been undertaken to define space debris.

In 2007, based on the definition elaborated and adopted by the Inter-Agency Space Debris Coordination Committee (IADC)[12] in the frame of its 'IADC Space Debris Mitigation Guidelines', the UNCOPUOS Scientific and Technical Subcommittee elaborated a draft that was later endorsed by the UN General Assembly in the same year.[13] In these UNCOPUOS Space Debris Mitigation Guidelines 'space debris' are defined as follows:

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[9] Reconsidering Space Debris: Can Space Junk Be Useful? In: Futurism, https://futurism.com/reconsidering-space-debris-space-junk-useful/.

[10] The launching state is defined in this Art. VII OST as the state "that launches or procures the launching of an object into outer space, (…), and each State Party from whose territory or facility an object is launched".

[11] Art. 1b REG.

[12] IADC is an international governmental forum for the worldwide coordination of activities related to the issues of man-made and natural debris in space, https://www.iadc-online.org/.

[13] UNGA Res. 62/217, 21 December 2007, International cooperation in the peaceful uses of outer space, para. 26.

> For the purpose of this document, space debris is defined as all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional.[14]

It should be emphasized that this definition of 'space debris' was elaborated and adopted "for the purpose of this document" and does not constitute any further binding international legal definition. Nevertheless, this definition has been taken up by several member states and organisations. Thus, the European Space Agency (ESA) explains space debris as follows: "Space debris is defined as all non-functional, human-made objects, including fragments and elements thereof, in Earth orbit or re-entering into Earth's atmosphere".[15] Also NASA has declared that "space debris encompasses both natural (meteoroid) and artificial (man-made) particles. Meteoroids are in orbit about the sun, while most artificial debris is in orbit about the Earth. Hence, the latter is more commonly referred to as orbital debris. Orbital debris is any man-made object in orbit about the Earth that no longer serves a useful function. Such debris includes non-functional spacecraft, abandoned launch vehicle stages, mission-related debris and fragmentation debris".[16] Moreover, in the IAA Cosmic Study on Space Traffic Management, it is underlined that "there is no legal distinction made between valuable active spacecraft and valueless space debris."[17] However, these statements and initiatives do not constitute legally binding rules.

5.2 Removal of Space Debris: Right, Obligation or Voluntary Option?

Since there is no legally binding definition of space debris, and a wide range of operations is possible to secure its removal, the question becomes: "Is there an obligation to remove space debris, and if so, is this a right or just a voluntary option?"

With regards to international space law, Art. I OST underlines the free use of outer space: "The exploration and use of outer space (…) shall be carried out for the benefit and in the interests of all countries (…), shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies". This article clearly stipulates that the use of outer space should be free for all and there should be free access. Consequently, all space actors should have the right to use outer space freely. Thus, if a space object of a nation hinders the free use

[14] Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, p. 1, pt. 1, http://www.unoosa.org/pdf/publications/st_space_49E.pdf.

[15] ESA, Space debris, http://www.esa.int/Our_Activities/Operations/Space_Debris/FAQ_Frequently_asked_questions.

[16] NASA, Space Debris and Human Spacecraft, https://www.nasa.gov/mission_pages/station/news/orbital_debris.html.

[17] Corinne Contant-Jorgenson, Petr Lála, Kai-Uwe Schrogl (eds.), IAA Cosmic Study on Space Traffic Management, 2006, p. 40, https://iaaweb.org/iaa/Studies/spacetraffic.pdf.

of space by others, this may be considered as a violation of Art. I OST. In addition, Art. IX OST clearly indicates the limits of free use of outer space by emphasizing that space actors have to conduct their operations in outer space "with due regard to the corresponding interests of all other States Parties to the Treaty".[18] Moreover, "harmful contamination"[19] should be avoided.

Even though there is no legally binding definition of harmful contamination, space debris that may constitute a risk for space activities can be considered as harmful contamination as this would constitute pollution of the Earth's environment and its orbits. In this regard, reference can be made to other international regulations and especially the 'Declaration of the United Nations Conference on the Human Environment' which in 1972 formulated Principle 21 that "States have, in accordance with the Charter of the United Nations and the principles of international law (…) the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction".[20] This obligation was echoed in Principle 2 of the 'Rio Declaration on Environment and Development' of 1992.[21]

Consequently, it can be deduced that there is clear obligation on states to ensure that space activities emanating from their area of jurisdiction do not damage the celestial environment. However, it can be argued that most space debris were created before these UN declarations were elaborated. But we can rely on the jurisprudence of the International Court of Justice (ICJ) which, in its Gabčíkovo-Nagymaros case, clearly stated that if a new international regulation were adopted to protect the environment, this new standard would apply not only to upcoming, but also to already ongoing operations: "Throughout the ages, mankind has, for economic and other reasons, constantly interfered with nature. In the past, this was often done without consideration of the effects upon the environment. Owing to new scientific insights and to a growing awareness of the risks for mankind - for present and future generations - of pursuit of such interventions at an unconsidered and unabated pace, new norms and standards have been developed, set forth in a great number of instruments during the last two decades. Such new norms have to be taken into consideration, and such new standards given proper weight, not only when States contemplate new activities but also when continuing with activities begun in the past."[22] Indeed,

[18] Art. IX OST.

[19] Art. IX OST.

[20] The United Nations Conference on the Human Environment, Stockholm, 5–16 June 1972, http://www.un-documents.net/unchedec.htm.

[21] The United Nations Conference on Environment and Development, Rio de Janeiro, 3–14 June 1992, http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm.

[22] ICJ, Case concerning the Gabčíkovo-Nagymaros Project (Hungary/Slovakia) judgment of 25 September 1997, para. 140, http://www.icj-cij.org/files/case-related/92/092-19970925-JUD-01-00-EN.pdf.

for the ICJ this approach is the only way to preserve the environment in view of a sustainable development."[23,24]

5.2.1 *Who May Remove Space Debris: Is There a Compulsory Link Between Space Debris and Ownership?*

Even if an obligation to remove space debris can be deduced from the international regulations and the jurisprudence of the ICJ discussed above, the question of who has the obligation or the right to remove space debris must be addressed. Moreover, a distinction must be made between removal of own, and removal of foreign, space debris.

As stated above, Art. VIII OST provides that the state of registry exercises jurisdiction and control: "A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body."[25] In addition, the "ownership of objects launched into outer space, include[s] (…) their component parts".[26] The right to exercise jurisdiction and control is important when considering any act of space debris removal.

The Registration Convention was adopted to clarify registration obligations by providing more detail. It states in Art. II para. 1 REG that "the launching State shall register the space object"[27] and, in para. 2 clarifies that "where there are two or more launching States in respect of any such space object, they shall jointly determine which one of them shall register the object".[28]

It can be concluded that the state of registry is entitled to remove its space debris, but is also obliged to do so to avoid any harm to the environment.[29] Clearly, the state of registry is also entitled to ask or to give permission to another state to carry out debris removal operations. But what happens if a state does not comply with its

[23] ICJ, Case concerning the Gabčíkovo-Nagymaros Project (Hungary/Slovakia) judgment of 25 September 1997, para. 140.

[24] In the domain of soft law, Guideline 6 of the UNCOPUOS Space Debris Mitigation Guidelines, which enjoins parties to "Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low-Earth orbit (LEO) region after the end of their mission" recommends that "Spacecraft and launch vehicle orbital stages that have terminated their operational phases in orbits that pass through the LEO region should be removed from orbit in a controlled fashion", http://www.unoosa.org/documents/pdf/spacelaw/sd/COPUOS-GuidelinesE.pdf. This UNCOPUOS guideline is non-legally binding and it is questionable if all space debris are covered by Guideline 6 as spacecrafts and launch vehicle orbital stages are only *expressis verbis* mentioned. Nevertheless it can be concluding that this embrace also its components.

[25] Art. VIII OST.

[26] Art. VIII OST.

[27] Art. II para. 1 REG.

[28] Art. II para. 2 REG.

[29] See above.

international obligations? Is another state then entitled to implement those obligations? There are no binding rules in this regard, although several attempts have been undertaken, such as the International Code of Conduct for Outer Space Activities.

5.2.2 *The International Code of Conduct for Outer Space Activities (ICoC)*

To ensure the sustainable use of the common outer space, the European Union (EU) has proposed the European Code of Conduct for Outer Space Activities, which has since been renamed "The International Code of Conduct (ICoC)".[30] The code was proposed by the EU to strengthen and enhance security, safety and sustainability in outer space, especially as one of the main EU aspirations in its space policy is "to encourage responsible behaviour in outer space".[31] Moreover, the proposed code "was made in response to a call for '*transparency & confidence-building measures*' among all space actors in two UN General Assembly Resolutions".[32] Both resolutions are entitled "Transparency and confidence-building measures in outer space activities", the first adopted in 2006,[33] the second in 2007,[34] and seek the more secure use of outer space.

However, the International Code of Conduct for Outer Space Activities initiative has encountered difficulties especially due to its Art. 4.2. This stipulates that states engage not to undertake any actions in space that directly or indirectly cause damage or destruction to space objects, unless these actions are justified. Such justification is based on three possible scenarios: prevention of a possible hazard to human life or health, the prevention or reduction of the emergence of new space debris, and measures provided by the UN Charter including the right to self-defence.[35]

> Art. 4.1. The Subscribing States resolve to establish and implement policies and procedures to minimise the risk of accidents in space, collisions between space objects, or any form of harmful interference with another State's peaceful exploration, and use, of outer space.

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[30] European External Action Service (EEAS) (2014): Draft International Code of Conduct for Outer Space Activities, Version 31 March 2014, https://eeas.europa.eu/sites/eeas/files/space_code_conduct_draft_vers_31-march-2014_en.pdf.

[31] EU External Action, Security and Sustainability in Outer Space, 14.01.2015, https://eeas.europa.eu/headquarters/headquarters-homepage/8466/security-and-sustainability-outer-space_en.

[32] EU External Action, Security and Sustainability in Outer Space, 14.01.2015, https://eeas.europa.eu/headquarters/headquarters-homepage/8466/security-and-sustainability-outer-space_en.

[33] Resolution 61/75 on Transparency and confidence-building measures in outer space activities, 2006, A/RES/61/75.

[34] Resolution 62/43 on Transparency and confidence-building measures in outer space activities, 2007, A/RES/62/43.

[35] "Refrain from any action which brings about, directly or indirectly, damage, or destruction, of space objects unless such action is justified", European External Action Service (EEAS) (2014): Draft International Code of Conduct for Outer Space Activities, p. 6, https://eeas.europa.eu/sites/eeas/files/space_code_conduct_draft_vers_31-march-2014_en.pdf.

> Art. 4.2. The Subscribing States resolve, in conducting outer space activities, to:
> - refrain from any action which brings about, directly or indirectly, damage, or destruction, of space objects unless such action is justified:
>   - by imperative safety considerations, in particular if human life or health is at risk; or
>   - in order to reduce the creation of space debris; or
>   - by the Charter of the United Nations, including the inherent right or individual or collective self-defence.
>
> and where such exceptional action is necessary, that it be undertaken in a manner so as to minimise, to the greatest extent practicable, the creation of space debris;
> - take appropriate measures to minimize the risk of collision; (…)

In consequence, the ICoC envisages the possibility of 'anticipatory intervention' that uses the right of self-defence to avoid the creation of space debris before they damage other space assets. However, the use of self-defence in this case is controversial. In fact, the right to self-defence, or the possibility of avoiding debris by destroying a space object, has been questioned especially by Russia, which sees it as a pretext to destroy the space objects of other states. In this context it should be underlined again that an intact space infrastructure is not only vital for the survival of industrialized countries, but for a steadily increasing community of states. Therefore, Russia has introduced several proposals at the UNCOPUOS level to initiate a debate on the use of self-defence in space.[36] Moreover, some Latin American countries consider that the foreseen reference to Art. 51 of the UN Charter, and the right to self-defence therein, constitutes more of a source of conflict and further militarisation than a way to secure space activities. Against this background, it is necessary to analyse in depth the relevant international legal norms in this regard.

5.3 International Legal Norms to Ensure Peaceful Behaviour in Space

The specialized space UN treaties, especially the Outer Space Treaty, were adopted to regulate activities in outer space to ensure security and peace in space. Other general international regulations, such as in the UN Charter, may also be relevant.

5.3.1 Relevant Specialized UN Space Treaties

The Magna Carta for space activities, the Outer Space Treaty stipulates in its Art. III

> States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, in accordance with international law,

[36] See: IV.1. Russian approach for a uniform interpretation of the right of self-defence in outer space in conformity with the UN Charter. p. XX.

> including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding.[37]

This article specifies clearly that space activities have to be carried out in "accordance with international peace, including the Charter of the United Nations" for the purpose of "maintaining international peace and security". In addition, Art. IV OST addresses possible future military intervention in outer space.

> States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.
>
> The Moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the Moon and other celestial bodies shall also not be prohibited.[38]

Although Art. IV OST deals with the important aspect of the peaceful use of space, many aspects remain unclear as the community of states during the drafting process of the OST did not envisage a general prohibition of military interventions, unrealistic at the time of the Cold War.

However, in the context of possible space missions for the purposes of active debris removal (for example ESA's e.Deorbit mission[39]), the use of military equipment may be considered as well. Unfortunately due to some unclear definitions in Art. IV OST, this may raise further questions and incertitude. In consequence, Art. IV OST should be analysed in detail.

5.3.1.1 Moving Weapons into Space (Art. VI, para. 1 OST)

Art. VI, para. 1 OST has already led to various controversial interpretations due to the unclear stipulation "not to place", since weapons do not have to be placed into orbit in order to activate them. A simple flight through would be sufficient. Accordingly, outer space may be used for the transport or fly through of nuclear weapons or weapons of mass destruction.[40] Also, the OST does not specify how to proceed with weapons that are not explicitly listed, since only "nuclear weapons or

[37] Art. III OST.

[38] Art. IV OST.

[39] ESA, Clean space, http://www.esa.int/Our_Activities/Space_Engineering_Technology/Clean_Space/e.Deorbit.

[40] A ballistic flight would therefore not be a violation of the treaty, but it is controversial whether weapons systems, which cover only part of their flight path in space, are really allowed. Therefore, in 1972, the United States and the Soviet Union signed the ABM (Anti-Ballistic Missiles) treaties to limit missile defence systems, as it was unclear whether these space-based systems were covered by the prohibition of Art. IV OST.

any other kinds of weapons of mass destruction" are mentioned in Art. VI, para. 1 OST. This could mean that weapon systems other than nuclear weapons/weapons of mass destruction are not subject to this restriction and could be placed into space.

In this context, reference should be made to the 'Treaty on Prevention of the Placement of Weapons in Outer Space and the Threat or Use of Force against Outer Space Objects' (PPWT), a proposal submitted by Russia and China to the Geneva Conference on Disarmament (CD) in February 2008. According to the proposed Treaty, no objects that carry any kind of weapon should be sent into Earth orbit and no weapons should be placed on celestial bodies. This text was presented again in a modified version in June 2014, but met with criticism. The United States for example raised security concerns and missing verification mechanisms.[41]

5.3.1.2 Definition of Peaceful Use (Art. IV, Para 2 and Para. 4 OST)

Furthermore, Art. IV, para. 2 OST states that the use of the Moon and other celestial bodies should be undertaken exclusively for "peaceful purposes". However, the term "peaceful use" is not further determined and is controversially interpreted. Does "peaceful use" mean no military use or only no aggressive military activities? If "peaceful" were to be considered non-military, then all military activities would be prohibited. If "peaceful" were to be considered non-aggressive, only aggressive activities in space would be prohibited, but not the use of military personnel and facilities (including space activities carried out by military personnel). In general, it is assumed that "peaceful" should be interpreted as "non-aggressive", unless the OST speaks of "exclusively for peaceful purposes" (Art. VI, para. 2 OST). In this case, no activities or facilities in a military context are possible.

However, it can be argued that the OST itself envisages certain military activities. While the testing of weapons of all kinds is prohibited (Art. IV, para. 3 OST), the use of "military personnel for scientific research or for any other peaceful purposes" (Art. IV, para 4 OST) is allowed, which may also be applicable in the context of space debris removal. In this context, questions arise about 'dual-use' activities in space, which is also of high relevance for the European Space Agency (ESA) as, according to Art. II of its statutes, the purpose of this organization "shall be to provide for and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications". Here it must be underlined that a multiplicity of applications and missions can have both a civilian and military character. Therefore, in regard to the peaceful use of outer space, it can be concluded that the OST guarantees the right to use outer space, however it is limited by Art. IV requiring that this use is peaceful. This will mostly be the case for active space debris removal. But it might also be contested by those who claim that active debris removal is only a pretext for destroying the space

[41] Jeff Foust, U.S. Dismisses Space Weapons Treaty Proposal As "Fundamentally Flawed", in: Spacenews.com, 11.09.2014, http://spacenews.com/41842us-dismisses-space-weapons-treaty-proposal-as-fundamentally-flawed/.

infrastructure of other states. In consequence, it is important to analyse the general regulations, especially those of the UN Charter, in this regard.

5.3.2 The UN Charter and the Use of Force

Art. III OST explicitly provides that the States Parties should carry out their space activities "in accordance with international law, including the Charter of the United Nations".[42] The UN Charter was elaborated after the Second World War and contains provisions related to the use of force. First, however, it is necessary to clarify preliminary questions around the general applicability of the UN Charter to extra-terrestrial spheres as, at the time of their drafting and adoption, the UN rules were primarily intended to ensure peace on Earth. Nevertheless, it is nowadays accepted that international law extends also to the first two levels around the Earth, i.e. terrestrial-lunar and interplanetary space (our solar system). Therefore, it is instructive to analyse the relevant articles on peace and security, especially Art. 2 (4) and Art. 51.

5.3.2.1 Art. 2 (4) The UN Charter and the Prohibition on the Use of Force

Art. 2 (4) of the UN Charter promulgates a general prohibition on the use of threat or force: "All Members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state, or in any other manner inconsistent with the Purposes of the United Nations".[43] The meaning of this article was reinforced by the International Court of Justice (ICJ) in its Nicaragua case,[44] which gave the status of international customary law to this article and its principle.

Art. 2 (4) UN Charter not only mentions the use of force "against the territorial integrity", but also "any other manner inconsistent with the Purposes of the United Nations", which extensively enlarges the scope of application of the right of self-defence. In addition, it must be highlighted that Art. 2 (4) not only encompasses territorial integrity, but also the "political independence of any state", which does not limit this right to territorial criteria. This was also endorsed by the ICJ in the Nicaragua case by underlining that this embraces a multitude of various rights of a State expressing its sovereignty. As noted above, states have to register their space objects. As registration is the constituting act for the right of the Registry state to exercise jurisdiction and control, this means it can exercise its right of suzerainty.

[42] Art. III OST.

[43] Art. 2 (4) UN Charter.

[44] Nicaragua Case, Military and Paramilitary Activities in and Against Nicaragua (Nicaragua v. United States of America), I.C.J. Report 1986, para. 190.

5.3.2.2 Art. 51 UN Charter and the Concept of Anticipatory Self-Defence

Chapter VII UN Charter is entitled "Action with respect to threats to the peace, breaches of the peace, and acts of aggression." Art. 51 UN Charter addresses the concept of "self-defence" by stipulating the inherent right of a state to act in self-defence in case of an armed attack:

> Nothing in the present Charter shall impair the inherent right of individual or collective self-defence if an armed attack occurs against a Member of the United Nations, until the Security Council has taken measures necessary to maintain international peace and security. Measures taken by Members in the exercise of this right of self-defence shall be immediately reported to the Security Council and shall not in any way affect the authority and responsibility of the Security Council under the present Charter to take at any time such action as it deems necessary in order to maintain or restore international peace and security.[45]

First, it must be noted that Art. 51 UN Charter applies only if an "armed attack occurs against a Member of the United Nations" without giving any further details concerning the location of such attack. The only qualification is that it must be against a UN Member State. In regard to the three-element doctrine, a state is based on state territory, state people and state power. As there is no territory in outer space, and especially as Art. II OST forbids any national appropriation in outer space, it may be deduced that the right of self-defence can only be carried out on Earth, against the territory of another Member State. However, due to the above-mentioned link created by the act of registration, a space object is part of and falls under the suzerainty of the Registry state that has the right to defend persons and objects belonging to its dominion.[46]

Furthermore, an act of self-defence must correspond to certain criteria—otherwise it may be considered as unlawful. In the Nicaragua case the ICJ stated: "with regard to the characteristics governing the right of self-defence, since the Parties consider the existence of this right to be established as a matter of customary international law, they have concentrated on the conditions governing its use. (…) The Parties also agree in holding that whether the response to the attack is lawful depends on observance of the criteria of the necessity and the proportionality of the measures taken in self-defence."[47] To concretise these elements, reference can be made to the draft articles on 'Responsibility of States for Internationally Wrongful Acts', which give more detail on the aspects of "necessity".

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[45] Art. 51 UN Charter.

[46] It is therefore an advantage to register space objects as this is the sole way to exercise suzerainty rights over them and to defend them in case of peril.

[47] Nicaragua Case, Military and Paramilitary Activities in and Against Nicaragua (Nicaragua v. United States of America), I.C.J. Report 1986, para. 194. http://www.icj-cij.org/files/case-related/70/070-19860627-JUD-01-00-EN.pdf.

Precluding the Wrongfulness of Removing Space Debris

The draft articles on 'Responsibility of States for Internationally Wrongful Acts' elaborated by the International Law Commission (ILC)[48] cover various special circumstances that can vitiate the wrongfulness of an act. First, Art. 20 mentions "Consent" ("Valid consent by a State to the commission of a given act by another State precludes the wrongfulness of that act in relation to the former State to the extent that the act remains within the limits of that consent"[49]). Indeed, in the context of active debris removal, the consent of the state of registry to the removal of its space debris can vitiate the wrongfulness of another state in removing the space debris of the state of registry. Art. 21 refers to "Self-defence" ("The wrongfulness of an act of a State is precluded if the act constitutes a lawful measure of self-defence taken in conformity with the Charter of the United Nations"[50]). The possibility of invoking self-defence in the context of the removal of space debris to avoid harm to other space operations has already been analysed above.

Another important circumstance is "Necessity"[51] as mentioned in Art. 25. 'Necessity' may be "invoked by a State as a ground for precluding the wrongfulness of an act not in conformity with an international obligation".[52] Nevertheless in order to invoke necessity, various criteria must be met. The action must be "the only way for the State to safeguard an essential interest against a grave and imminent peril"[53] and must "not seriously impair an essential interest of the State or States towards which the obligation exists, or of the international community as a whole."[54] In the field of space debris, the international community's interest is that no further threats are posed by space debris and it is hardly conceivable to see how the removal of space debris may impair the essential interest of its State owner (except if this state does not consider this object in space as space debris but as an non-operable space object necessary for further operations). In addition, a peril can be qualified as a "grave and imminent peril" even if its realisation will occur in the medium or long-time future. Indeed, the ICJ stated in the Gabčíkovo-Nagymaros case "that a 'peril' appearing in the long term might be held to be 'imminent' as soon as it is established, at the relevant point in time, that the realization of that peril, however far off it might be, is not thereby any less certain and inevitable".[55]

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[48] International Law Commission (ILC), Draft articles on 'Responsibility of States for Internationally Wrongful Acts', text adopted by the Commission at its fifty-third session in 2001 and submitted to the UN General Assembly, http://legal.un.org/ilc/texts/instruments/english/draft_articles/9_6_2001.pdf.

[49] ILC, Draft articles on 'Responsibility of States for Internationally Wrongful Acts', Art. 20.

[50] ILC, Draft articles on 'Responsibility of States for Internationally Wrongful Acts', Art. 21.

[51] ILC, Draft on 'Responsibility of States for Internationally Wrongful Acts', 2001, http://legal.un.org/ilc/texts/instruments/english/draft_articles/9_6_2001.pdf.

[52] Art. 25, para. 1.

[53] Art. 25, para. 1a.

[54] Art. 25, para. 1b.

[55] ICJ, Case concerning the Gabčíkovo-Nagymaros Project (Hungary/Slovakia) judgment of 25 September 1997, para. 54.

The Concept of Anticipatory Self-Defence and Preventive Actions

Art. 51 states "Nothing in the present Charter shall impair the inherent right of individual or collective self-defence if an armed attack occurs against a Member of the United Nations". On a strict reading, the article only applies "if an armed attack occurs". But what happens if an imminent attack is obvious which may lead to significant damage for the victim state. Should the state wait and first endure the attack? Can the state victim act legally in advance and claim self-defence to avoid damage to its country, its population or goods? (Especially taking into account that it will take a certain time for the UN Security Council to take the measures indicated in Art. 51 UN Charter). At a time where one strike with a weapon of mass-destruction can have an enormous destructive, even extinguishing, effect for the affected state, it is legitimate to advocate an anticipatory right of self-defence as the affected state may otherwise no longer exist or be able to exercise its right of self-defence.

The question of the right to anticipatory self-defence was already widely debated before the drafting of the UN Charter, especially in the frame of the Caroline[56] case.[57] Even in the nineteenth century, International customary law accepted a pre-emptive lawful use of force as self-defence. During the Caroline case the criteria for this right were elaborated, namely "necessity" ("necessity of self-defence, instant, overwhelming, leaving no choice of means, and no moment for deliberation"[58]), meaning that the attack is imminent ("conditionality of an attack denotes both the occurrence and expectation of an armed attack"[59]), and the condition of "proportionality" (that the considered measures to take in self-defence are the only way to avoid the threat/attack).

In the wake of the 11 September 2011 tragedies, the US administration under President G.W. Bush decided that the right of (anticipatory) self-defence had to be reconsidered and adapted to meet the threat from high-tech weapons. A new strategy was presented which included the concept of pre-emption. Therefore, the US National Security Strategy (NSS) announced that despite the traditional criterion of imminence for anticipatory self-defence, the US "must adapt the concept of imminent threat to the capabilities and objectives of today's adversaries."[60] It underlined that "[t]he greater the threat, the greater is the risk of inaction—and the more compelling the case for taking anticipatory action to defend ourselves, even if uncertainty remains as to the time and place of the enemy's attack."[61] As this

[56] The destruction of the small vessel Caroline occurred on 20 December 1837.

[57] The Caroline Case, British-American Diplomacy, http://avalon.law.yale.edu/19th_century/br-1842d.asp.

[58] Daniel Webster, Letter from Daniel Webster, US Secretary of State to Henry Fox, British Minister in Washington, 24 April 1841, p. 1138.

[59] Kinga Tibori Szabó, Anticipatory Action in Self-Defence, 2011, p. 292.

[60] The National Security Strategy of the United States, September 2002, www.whitehouse.gov/nsc/nss.html.

[61] The National Security Strategy of the United States, September 2002, www.whitehouse.gov/nsc/nss.html.

anticipatory self-defence may be used also in the case of "uncertainty", it turns pre-emptive actions into a purely political decision.[62]

5.4 Further Initiatives on the Use of Self-Defence to Mitigate Space Debris

The right of self-defence was also discussed in other fora, e.g. the delegation of the Russian Federation advocated initiating a debate during the UNCOPUOS sessions. Furthermore, discussions within the first UN Committee were initiated in the context of a possible treaty and resolutions in this regard. In addition to the ICoC, the EU has proposed multilateral non-legally binding instruments on space security to foster the safe and sustainable use of outer space, as elaborated below.

5.4.1 Russian Approach for a Uniform Interpretation of the Right of Self-Defence in Outer Space in Conformity with the UN Charter

For some years now, the Russian delegation to UNCOPUOS has raised the question of the right of self-defence in outer space and its conformity with the UN Charter. Russia has advocated a uniform interpretation of this right and in 2015 submitted a working paper entitled "Achievement of a uniform interpretation of the right of self-defence in conformity with the Charter of the United Nations as applied to outer space as a factor in maintaining outer space as a safe and conflict-free environment and promoting the long-term sustainability of outer space activities".[63] In its statement of 12 June 2017, Russia said that this aspect "has great significance for the entire space safety and security discipline". Furthermore, it stated:

> the unfortunate thing is that some States prefer not to discuss this issue. The reasons for this are different. There are those who hold the position that it would be intolerable and cynical even to raise the question of self-defence in outer space. The moral aspect of such a position is understood, but, to be frank, it is not exactly in correlation with realities. And, of course, there are those who might not be enthusiastic about dwelling into the problem here in the Committee simply because in conceptualizing self-defence in space they have by far surpassed the concept characterizing the UN Charter's Article 51 by providing for preventive, preemptive and even anticipatory self-defence in outer space. The Charter of the United Nations certainly does not provide for such types of self-defence in its radicalized form, either in Earth or anywhere. Some national policy instruments refer to self-defence in outer space as being a customary norm. And this is something to be discussed for sure since

[62] Edward G. Ferguson/John J. Klein, It's Time for the U.S. Air Force to Prepare for Preemption in Space -Without a preemption strategy, the United States is vulnerable-, 22 April 2017, https://warisboring.com/its-time-for-the-u-s-air-force-to-prepare-for-preemption-in-space/.

[63] UNCOPUOS, 58th session, Vienna, A/AC.105/L.294, 29 April 2015.

> customs comprise habitual practices of States which are regarded as binding on all States. This is a classical description of what customary law is all about. We find it difficult to recollect any events that could be interpreted as forming a sustained practice of self-defence particularly in outer space.[64]

In the ensuing discourse, it claimed that the "absolute majority of States would hardly respond to an assertion that such customary law norm actually exists." Moreover, the delegation of the Russian Federation clearly declared that "*Russia upholds the position that it would be very important for the international community to reach a common understanding of how to interpret the relevant provisions of the UN charter as they may hypothetically apply to outer space. In case such an understanding is reached, it would have to be approved by the General Assembly and the Security Council*".[65] For these reasons, Russia advocated a detailed analysis of this aspect. ("The examination of the problem of self-defence in outer space may lead to quite interesting outcomes."[66])

Furthermore, the delegation of the Russian Federation again expressed its reservations concerning the draft ICoC:

> The well-known draft Code of conduct in outer space activities featured salient paragraph 4.2 that claimed reason and validity for a rather strange concept providing for suprajurisdictional coercive measures with respect to foreign space objects on rather preposterous grounds such as space debris mitigation or superior safety considerations. We tried to figure out the intention behind it. The pursuit of explanation here was in vain, since the attempts to explain such a new paradigm have been poor. We can say absolutely for sure that it would not be conceivable for either State that has advanced this idea to have its own space object destroyed by any other State. To be frank, this concept seemed to be based on the presumption of somebody possessing a monopoly of coercive force in outer space.[67]

Therefore, the Russian delegation urged the UNCOPUOS to have further discussions on this topic. "We sincerely believe that the Committee should set itself a very practical task of analysing different behavioural situations and behavioural responses. Achieving understandings here would serve practical needs in mitigating conflict eruption. Such positive thinking process could well naturally lead to agreeing on self-defence in its far more reserved (restrained) expression".[68]

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[64] Statement by the Delegation of the Russian Federation at the 60th session of the Committee on the Peaceful Uses of Outer Space on agenda item 5: Ways and means of maintaining outer space for peaceful purposes, 12 June 2017, pp. 1–2.

[65] Statement by the Delegation of the Russian Federation at the 60th session of the Committee on the Peaceful Uses of Outer Space on agenda item 5: Ways and means of maintaining outer space for peaceful purposes, 12 June 2017, p. 2.

[66] Statement by the Delegation of the Russian Federation at the 60th session of the Committee on the Peaceful Uses of Outer Space on agenda item 5: Ways and means of maintaining outer space for peaceful purposes, 12 June 2017, p. 2.

[67] Statement by the Delegation of the Russian Federation at the 60th session of the Committee on the Peaceful Uses of Outer Space on agenda item 5: Ways and means of maintaining outer space for peaceful purposes, 12 June 2017, pp. 2–3.

[68] Statement by the Delegation of the Russian Federation at the 60th session of the Committee on the Peaceful Uses of Outer Space on agenda item 5: Ways and means of maintaining outer space for peaceful purposes, 12 June 2017, p. 3.

Moreover, the Russian delegation stated in its "General exchange of views"[69] that

> different States treat the issue of self-defence in outer space differently. (…) They need to be discussed. (…) Why do some colleagues think that this issue is beyond the call of duty of this Committee? Why do some colleagues tend to resist a sound proposal to have legal grounds for self-defence in space examined. The basic concern of the Russian working paper A/AC.105/L.294 is to explain problems associated with self-defence in outer space rather than to propagate the principle as such.[70]

Several topics related to self-defence in outer space are analysed in the working paper presented by the Russian delegation in 2015: "Achievement of a uniform interpretation of the right of self-defence in conformity with the Charter of the United Nations as applied to outer space as a factor in maintaining outer space as a safe and conflict-free environment and promoting the long-term sustainability of outer space activities". The paper underlines that various aspects of safety and security of space activities are closely interrelated with numerous ongoing initiatives and projects, including in the Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities, and the Working group for the development of guidelines for ensuring the long-term sustainability of outer space activities.[71]

Further, the Russian paper emphasises that even if Russia advocates a discussion on the legal basis for exercising the right of self-defence in outer space, "t(T)his initiative does not in any way contradict the fundamental value of preserving outer space as a conflict-free environment: on the contrary, it is aimed at streamlining the logic of studying the interrelationships among all security factors in outer space and designing a joint systemic approach to ensuring such security."[72] Therefore, the aim of the paper is rather to engage in a discussion to reach a common understanding and way of interpretation of 'self-defence' because the Russian delegation considers 'self-defence' more a political concept than an international legal notion. Therefore, there may be a risk that not all states have the willingness to bring their concept of self-defence in outer space in conformity with the provisions of the UN Charter, which may lead to a situation of conflict, especially as different geopolitical interests may be involved.[73]

In summarizing, this Russian initiative has so far not triggered any further consequences such as debates or the establishment of a specialised working group in the frame of UNCOPUOS. This may be because other member states know that this is more a topic for only a few countries e.g. China, the US and Russia, which hold the highest percentage of dysfunctional space objects in orbit. Nevertheless, at UNCOPUOS Russia always opposes any ideas of removal of space debris by other states that consider active debris removal as a means to ensure the sustainable development of outer space.

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[69] Statement by the Delegation of the Russian Federation at the 60th session of the Committee on the Peaceful Uses of Outer Space on agenda item 4: General exchange of views, 7 June 2017.

[70] Statement by the Delegation of the Russian Federation at the 60th session of the Committee on the Peaceful Uses of Outer Space on agenda item 4: General exchange of views, 7 June 2017, pp. 3–4.

[71] UNCOPUOS, 58th session, Vienna, A/AC.105/L.294, 29 April 2015, p. 1, pt. 1.

[72] UNCOPUOS, 58th session, Vienna, A/AC.105/L.294, 29 April 2015, p. 2, pt. 2.

[73] UNCOPUOS, 58th session, Vienna, A/AC.105/L.294, 29 April 2015, pp. 2–3, pt. 3.

5.4.2 *Proposals for Multilateral Non-legally Binding Instruments on Space Security by the EU*

In its Statement on the Prevention of an Arms Race in Outer Space of 16 June 2017[74] at the Conference on Disarmament Working Group on the "Way Ahead", the EU underlined that its member states would "continue promoting the preservation of a safe and secure space environment and the peaceful use of outer space on an equitable and mutually acceptable basis." Due to the increased number of actors and activities, it stated that it is "both more complicated and more necessary to develop new norms and rules governing human activity in space". With reference to its proposed Code of Conduct, the EU underlined that it "demonstrated leadership and willingness to work with the international community on space issues". Therefore, the EU insisted that further global principles were needed to ensure safe and secure space environment. Those new principles should complement existing rules and initiatives and "should address the full range of space activities and related challenges such as space debris, space traffic management, collision avoidance and prevention of an arms race in outer space and should hence serve long term goals: to increase international cooperation in space, to commit mutually to debris mitigation and to non-interference in the peaceful exploration and use of outer space, to facilitate an equitable access to outer space and increase transparency in the conduct of space activities."[75] For the EU, this new non-legally binding instrument is a tool to achieve greater security and safety, and space debris is specifically mentioned.

5.4.3 *Further Initiatives to Strengthen Space Security by Taking into Account Space Debris and the Right of Self-Defence*

In the context of active space debris removal, reference should first be made to the draft[76] submitted by China and Russia jointly at the UN First Committee in February 2008 entitled '*Treaty on the Prevention of the Placement of Weapons in Outer*

[74] European Union/External Action, Statements on behalf of the EU, Geneva, 16 June 2017, https://eeas.europa.eu/headquarters/headquarters-homepage/28329/conference-disarmament-working-group-way-ahead-eu-statement-prevention-arms-race-outer-space_en.

[75] European Union/External Action, Statements on behalf of the EU, Geneva, 16 June 2017, https://eeas.europa.eu/headquarters/headquarters-homepage/28329/conference-disarmament-working-group-way-ahead-eu-statement-prevention-arms-race-outer-space_en.

[76] Draft 'Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects' (PPWT), https://www.unog.ch/80256EDD006B8954/(httpAssets)/C4CD83AD4A8B4797C1257CF3003AC425/%24file/1319+Russian+Federation+Draft+Updated+PPWT+.pdf.

Space, the Threat or Use of Force against Outer Space Objects (PPWT)'.[77] The draft elaborates several definitions. Art. 1b defines 'weapons in outer space' as *"any outer space object or its component produced or converted to eliminate, damage or disrupt normal functioning of objects in outer space, on the Earth's surface or in the air, as well as to eliminate population, components of biosphere important to human existence, or to inflict damage to them by using any principles of physics"*.[78] Moreover, Art. 1c concretises what should be understood by 'placed in outer space' (*"A device is considered as 'placed in outer space' when it orbits the Earth at least once, or follows a section of such an orbit before leaving this orbit, or is placed at any location in outer space or on any celestial bodies other than the Earth"*[79]*)*. In addition, Art. IV draft PPWT states that *"this Treaty shall by no means affect the States Parties' inherent right to individual or collective self-defense, as recognized by Article 51 of the UN Charter"*[80] without providing more detail in regard to this right. Even though the draft treaty explicitly affirmed the inherent right of self-defence, it was not adopted. Among other aspects, it was opposed by the U.S. due to security concerns in regard to their space assets.

Second, despite the failure of the draft treaty, a resolution entitled 'No First Placement of Weapons in Outer Space' (NFP)[81] was adopted with 126 votes in favour, 4 against (Georgia, Israel, Ukraine, US[82]) and 46 abstentions.[83] This encouraged states to a political commitment not to be the first to place weapons in space. The EU abstained. By way of explanation of its abstention, it emphasized that the EU and its Member States had always advocated safe space travel and the peaceful use of space and considered the sustainable use of space as a common priority. Consequently, the EU had developed the ICoC where space debris and self-defence were covered. However, with regard to the submitted resolution, the EU was of the view that *"this particular initiative does not adequately respond to the objective of strengthening trust and confidence between States, but could rather increase the risk of conflict in space"*.[84] In addition, this resolution lacked a definition of what is to be regarded as a "weapon in space". This could lead to misunderstandings (*"The NFP initiative does not address the difficult issue of defining what a weapon in outer space is, which could lead a State to mistakenly assess that another State has placed*

[77] United Nations General Assembly Session 61 Verbatim Report 67, A/61/PV.67, p. 6, 6 December 2006.

[78] Art. 1b draft PPWT.

[79] Art. 1c draft PPWT.

[80] Art. IV draft PPWT.

[81] Resolution A/RES/69/32, 12 December 2014, initially co-sponsored by Brazil, China and Russia.

[82] United States Mission to the United Nations, Explanation of Vote in the First Committee on Resolution L.54, Agenda Item 97(b): No First Placement of Weapons in Outer Space, New York, 30 October 2017, https://usun.state.gov/remarks/8084.

[83] Staff Writers, UN passes resolution banning arms race in outer space, SpaceDaily, 05.12.2014, http://www.spacedaily.com/reports/UN_Passes_Russian_Proposed_Resolution_Banning_Arms_Race_in_Outer_Space_999.html.

[84] Explanation of Vote delivered by Estonia on behalf of European Union Member States, pt. 8.

weapons in outer space. Without a common understanding of what constitutes a weapon in space, a State could inadvertently put an object in space that another State considers to be a weapon"[85]*).*

Furthermore, the EU member states were concerned about the further development of anti-satellite weapons. Therefore, the EU considered it as urgent to include them in international efforts to avoid an arms race in space. Instead of an NRP pledge, it would thus make more sense to place the behaviour of the space actors as the focus of efforts for the peaceful use of space (*"to address the behaviour in, and use of, outer space in order to advance meaningful discussions and initiatives on how to prevent space from becoming an arena for conflict and to ensure the long-term sustainability of the space environment"*[86]*).*

5.5 Conclusion: Already Struggles by Concretising 'Peaceful Use of Space' for Discussion Fora

The discussion during the opening of the UNCOPUOS session in June 2017 reveals how difficult it is to evaluate the peaceful use of outer space, as the committee also had to deliberate on the request of the Democratic People's Republic of Korea to attend its sixtieth session as observer. Indeed, "some delegations expressed their strong concern (…). Those delegations were of the view that the status of the Democratic People's Republic of Korea as an observer of the Committee was inconsistent with repetitive violations by that State of Security Council Resolutions 1718 (2006), 1874 (2009), 2087 (2013), 2094 (2013), 2270 (2016), 2321 (2016) and 2356 (2017). Those delegations were of the view that such participation in the Committee's session misrepresented that country's space programme as peaceful, while in fact, that was manifestly not the case, as any space launch by the Democratic People's Republic of Korea using ballistic missile technology directly violated the Security Council resolutions and brought that country closer to its stated objective of creating a nuclear-armed intercontinental ballistic missile".[87] However, other member states of this Committee opined that "the Committee was a platform for discussion among all Member States and that it should be inclusive for all States, irrespective of their level of social and economic development, and thus all Member States had equal right to familiarize themselves with topical matters relating to the peaceful uses of outer space".[88] This argument opened the path for North Korea to attend as an observer the discussion around the peaceful use of outer space within UNCOPUOS

[85] Explanation of Vote delivered by Estonia on behalf of European Union Member States, pt. 9.

[86] Explanation of Vote delivered by Estonia on behalf of European Union Member States, pt. 10.

[87] Report of the Committee on the Peaceful Uses of Outer Space, Sixtieth session, 7–16 June 2017, A/72/20, pt. 8.

[88] Report of the Committee on the Peaceful Uses of Outer Space, Sixtieth session, 7–16 June 2017, A/72/20, pt. 9.

and reveals how much effort it needs already to define this notion of "peaceful use of outer space", an effort which will be even more difficult for activities related to active space debris removal.

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Chapter 6
The Degree of the Lack of Regulation of Space Debris Within the Current Space Law Regime and Suggestions for a Prospective Legal Framework and Technological Interventions

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Abstract The purpose of this research is to analyse the current international legal regime (referred to as "First-Generation Space Law") with regard to the issue of space debris management, specifically mitigation and eradication. Against this analysis a technological framework is introduced in order to monitor current and prospective space debris removal technologies that enables the design of a framework law regime to address the growing problem of space debris. Both the analysis of the current international legal regime and the design of the framework law regime provide insight into the uncertain nature of the current international law on space debris management that is not conducive to a solution to the space debris problem. The argument is thus advanced that the time has come for the Second-Generation Space Law to be developed in this regard.

Acronyms/Abbreviations

COPUOS	United Nations Committee on the Peaceful Uses of Space
FGSL	First Generation Space Law
Liability Convention (LC)	Convention on International Liability for Damage Caused by Space Objects

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Moon Agreement (MA)	Agreement Governing the Activities of States on the Moon and Other Celestial Bodies
Outer Space Treaty (OST)	Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies
Registration Convention (CR)	Convention on Registration of Space Objects Launched into Outer Space
Rescue Agreement (RA)	Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space
SDRR	Space Debris Regulation Regime
SGSL	Second Generation Space Law
UN	United Nations

6.1 Introduction

Since the launch of Sputnik in 1957, space activities have resulted in many scientific discoveries, positive technological advances and numerous space-based services in communication and remote sensing, amongst others. Unfortunately, it has also resulted in a multitude of space debris orbiting earth at dangerous velocities exposing existing space assets and human operations to huge probabilities of damage and danger.

Given the New Space paradigm currently unfolding in the space industry in the form of increasing private enterprise investment in space development and activities, it is not surprising that a growing body of research focuses on the mitigation and removal of space debris. While altruistic reasons also serve as motivation in developing this technological base, it is actually economic opportunities that are driving many technological developments in this regard.

However, while there is no shortage of technological research aimed at finding mechanisms to mitigate and/or eradicate space debris, many legal questions are raised. These include: does an effective international legal regime exist in this regard; if not, does one need to be established, and, if so; what form should it take? These questions cannot be answered without having regard to the unfolding technological environment to ensure the adoption of a forward-looking paradigm that will be able to deal with future developments in whatever form they may come.

This study investigates the current international legal regime and the unfolding technological environment in order to establish the form of regulation needed, and to design a possible framework legal regime that will be enabling in addressing the growing problem of space debris.

In this process of investigation two novel ideas are introduced: a system of space law to facilitate the understanding of current law and the development of new law; and, a taxonomical tool for technological assets that can assist in the design of a space debris regulatory regime, as well as legal regimes in other fields of space activities.

6.2 A New Perspective on Space Law

Space law, as public international law that is tangentially and transversally connected to various other fields of law, is a developing field of law within an increasingly complex environment, and with an increasing array of space activities from a variety of old and new role players. It is useful, therefore, to reflect upon the systematic positioning of space law within history so as to ensure that a logically consistent paradigm of law, framing reality as it flows from the past into the present and ultimately the future, is presented for ease of use and systematic development.

Having regard to the historical development of space law, its current status, and possible and probable future trends, space law can be divided into the following categories:

i) 'Macro' law: This consists of both 'hard law' and 'soft law'. "Hard law' comprises the five outer space treaties, related treaties dealing with space activities tangentially, and international customary law—all of which is binding on states based on consent or conduct. 'Soft law'—that is non-binding and guiding in nature—includes the United Nations (UN) principles, declarations, and resolutions, as well as guidelines issued by various international and regional bodies (whether UN affiliated or not), such as codes of conduct, model laws etc.;
ii) 'Micro' law: consisting of inter-state cooperation agreements that come into existence by way of mutual consent in bilateral or multilateral form, deals with matters or projects specific to the states involved, and is usually guided and informed by 'macro' law.

Importantly, 'macro' law consists mostly of broad philosophical orientations, general principles, various obligations, and specific prohibitions. 'Macro' law generally does not deal with the minutiae of specific space activities, initiatives or projects, but provides broad overarching or universal rules. As for specific regulation of individual space activities, initiatives or projects, it is incumbent upon the legal tools arising from the field of 'micro' law, such as contracts, to ensure consensus and binding obligations. Therefore, 'macro' law serves as the skeletal structure of space law whereas 'micro' law serves as the muscles and sinews of this body of law.

Further to the above exposition, it is important to note on a temporal scale that while this systematic framework is applicable to the current framework of space law that mostly originated in the cold war era, it might not necessarily be so in future. The current trend is to create and apply 'soft law', and there seems to be broad consensus that the five treaties are for now settled. Obviously, international custom can still develop as new activities become customary and accepted as such. This body of law to date can be regarded as First Generation Space Law (FGSL).

However, with the advent of the New Space era, new space activities are challenging the FGSL and interpretations given to core provisions of the space law treaties, such as the non-appropriation rule that permeates them all via Article II of the *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* (Outer Space Treaty

(OST)). On the one hand there is growing pressure to make amendments to ensure private ownership in space and on celestial bodies, but also a counter-push to revive the *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (Moon Agreement) with its emphasis on the prohibition of appropriation and its focus on benefit-sharing.

The need for greater legal certainty and an enabling legal regime for the burgeoning private enterprise in space is of the utmost importance. While the FGSL was designed with nation states as the main role players in mind, and focused mostly on international security and scientific exploration, it could stifle the New Space era or, even worse, become ineffective as nation states enact local laws enabling private space development and activities while ignoring the FGSL. The time is thus ripe to reflect on the establishment of legal certainty that enables new developments and regulates these activities for the greater public good of the planet. It is thus time to develop Second Generation Space Law (SGSL).

As will be shown *infra*, regulation of the mitigation and eradication of space debris will form part of the developing SGSL.

6.3 Space Debris Regulation

Space debris mitigation and eradication—referred to herein as the Space Debris Regulation Regime (SDRR)—is addressed in the body of the FGSL. A brief outline of the various references follows:

6.3.1 The Five Space Treaties (Hard Law)[1]

The point of departure is the Magna Carta of space law, namely the Outer Space Treaty.

6.3.1.1 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies

The OST establishes the codified foundations of the international space law regime and emerged from the United Nations' *Declaration of Legal Principles Governing the Activities of States in the Exploration of and Use of Outer Space* (Outer Space

[1] United Nations Treaties and Principles on Outer Space, related General Assembly resolutions and other documents, *UN Office for Outer Space Affairs*, 2013, http://www.unoosa.org/res/oosadoc/data/documents/2013/stspace/stspace61_0_html/st_space_61E.pdf (accessed on 20 December 2017).

Declaration (OSD)). Due to its unanimous adoption, the OSD is considered to constitute international customary law.[2] The OST is the codification thereof and forms the foundation of the four subsequent space law treaties.

As far as the SDRR is concerned, while the OST does not refer to it specifically, it does create certain principles and obligations that affect it, set out as follows:

- **Article I:** Importantly, the right to free access to space for exploration and use by states is hereby established. However, the increasing swarm of orbiting space debris will in future inhibit this fundamental right. The question that arises is whether this part of the global commons, referred to as the 'province of mankind', should not be protected by all parties to the OST by virtue of a space launch and orbital tax on launching states that will result in a 'clean-up fund' that can finance new technologies able to eradicate space debris?
- **Article VI:** The obligation is hereby established that states party to the OST shall bear "international responsibility for national activities in space". This obligation was later fully developed in the *Convention on International Liability for Damage Caused by Space Objects* (Liability Convention (LC)). Whether this establishes any liability with regard to space debris shall be discussed *infra*.
- **Article VII:** The obligation with regard to liability for damage caused in space is hereby established and is further elaborated in the LC, to be discussed *infra*. Of importance for the SDRR is that component parts of an object launched into outer space are also considered as a possible cause of damage and can result in liability.
- **Article VIII:** Establishes the link between jurisdiction, control and ownership of a space object and its component parts through implementation of a registry. This provision gave rise to the adoption of the *Convention on Registration of Space Objects Launched into Outer Space* (Registration Convention (CR)), to be discussed *infra*.
- **Article IX:** Establishes the important obligation that states and those under their jurisdiction shall pursue studies of outer space and conduct exploration in a manner so as to avoid harmful contamination. Given the extent of the space debris problem, it is quite clear that this obligation has not been adhered to by states party to the OST. The question now turns to the further mitigation of the increase of space debris on the one hand, and the rehabilitation of orbital space to ensure compliance with this obligation, on the other.

The next space law treaty that is applicable to the SDRR is the second space law treaty adopted, namely the *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space* (Rescue Agreement (RA)).

[2] Dugard, J. 2012. International Law. A South African Perspective. Cape Town: Juta.

6.3.1.2 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space

The RA is drafted to ensure the rescue of astronauts and the return of space objects and their component parts from jurisdictions other than that of the "launching authority", which in this case refers to the state responsible for launching. Article 5.3, however, does make mention of the return of space objects or their component parts to the "launching authority" recovered beyond the territorial limits of the "launching authority".[3]

This raises the question whether this provision is also applicable to orbital space debris recovered by a state, or any organization or company under its jurisdiction. There is no certainty in this regard as yet, however, a case can be made that the RA is focused on the return of space objects and their component parts found in territories on Earth and thus is not intended to deal with debris recovered in outer space.

6.3.1.3 Convention on International Liability for Damage Caused by Space Objects

The LC deals with damage caused by space objects and the establishment of liability by the "launching State", which is defined as either a state that launches or procures the launch of a space object or means a state from whose territory or facility a space object is launched. Of further importance for the SDRR is the definition of "space object" that includes "component parts of a space object as well as its launch vehicle and parts thereof". The question arises whether the definition of "space object" is wide enough to include space debris. It also elicits the further question: what is actually regarded as space debris? Can space debris also be regarded as entire component parts—whether damaged or not—abandoned in space by the "launching State"? Conversely, can derelict and broken-off pieces of a space object, irrespective of size, be regarded as a "space object" for the purposes of the LC?

The answers are important as they affect the applicability of the LC's liability provisions on space debris. In the event that space debris is found to be encompassed, then this treaty will have a far-reaching effect on the liability of "launching States", given the extensive regulation of liability by this treaty. In this case, a "launching State" will be liable for damage caused by its space object in the form of space debris if it is at fault. This means that negligence or intention must be proven before liability is vested and thus serves as a shield against liability in cases where events beyond the "launching State's", control results in debris creation and damage.

It is thus of the utmost importance that certainty is created regarding the definition of "space object". The answer to this question might be found in the *Convention*

[3] See note 2.

on Registration of Objects Launched into Outer Space (Registration Convention (RC)) that links registration of space objects to liability in terms of the LC.

6.3.1.4 Convention on Registration of Objects Launched into Outer Space

The RC connects the identification of space objects with their 'owners' i.e. the State of registry and any liability that might result from damage created by space objects. An obligation is placed on a "launching State", that is defined similar to the definition in the LC, to register in an "appropriate registry" any space object "launched into Earth orbit or beyond…".[4] The information in the registry must be communicated to the Secretary-General of the United Nations.

The definition of a "space object" is the same as in the LC, and thus unfortunately raises the same problems of interpretation as that found in the LC. Once again, the question arises if the term "component parts" includes space debris. Normally space debris would be parts and pieces of space objects that have been abandoned by any launching State, whether intentionally or by necessity due to the impossibility of recovering the parts or pieces. However, should the definition of "space object" be construed to include space debris, then abandonment shall never be a shield to liability as the space object is identifiable by virtue of a registry that establishes ownership and jurisdiction even long after the launching State has lost interest in the lost space object.

Given the right to free access to space by virtue of Article I of the OST, and the obligation against the contamination of space by virtue of Article IX of the OST, an argument can be construed that space debris must form part of the definition of "space object" in the LC and RC and that a launching State will be held liable for damage caused by its identifiable space debris in cases where it was at fault. Negligence will then arise when the launching State has not taken care to mitigate space debris. Liability based on intent can also arise, such as in the case of the Chinese destruction of one of its own satellites with a missile in 2007, resulting in damage to a Russian satellite due to a collision with space debris from the Chinese satellite.[5]

However, since a soft law instrument has been created to deal with the SDRR—to be discussed *infra*—questions are raised as to whether the international space community intends to treat space debris as part of the definition of "space object".

The last of the five space law treaties, namely the *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (Moon Agreement (MA)), deals with space activities removed from the orbital space around Earth and is thus not currently relevant to this enquiry.

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[4] See note 2.

[5] Russian Satellite hit by debris from Chinese anti-satellite test, *Space.com*, 8 March 2013, https://www.space.com/20138-russian-satellite-chinese-space-junk.html (accessed on 20 December 2017).

6.3.2 Related Treaties (Hard Law)

There is no evidence that related treaties can impose imperative legal rules on SDRR. One study, however, does provide insight into the effect that the application of the rules of Environmental Protection Agreements might have on space debris mitigation from an economic perspective. Singer and Mussachio argue that the creation of coalitions of states to deal with post-mission deorbiting of space craft, where equitable transfers take place to alleviate asymmetries of costs and benefits among the members, is workable. This means that 'micro' law tools of international agreement must be applied in the absence of 'micro' law certainty to achieve the establishment of the mooted coalitions.[6]

The search for legal certainty within the FGSL will thus have to be continued by having regard to customary international law and soft law.

6.3.3 Customary International Law (Hard Law)

Currently, customary international law does not create any known rules with reference to the SDRR except for the obligation not to contaminate space as established in the OSD and codified in the later OST. Through state practice and intention to be bound, the soft law, alluded to *infra*, could eventually become customary international law. However, these rules are mitigating in nature only.

As for the rules that would be used in any space debris eradication process, no state practice of actual eradication exists except for the practice on space object life spans and re-entry burn-up procedures, which also forms part of the mitigation soft law guidelines discussed below. It can be argued that these rules constitute customary international law due to their wide practice with the intention to mitigate and eradicate additional space debris, but as they are included in the soft law discussed *infra*, they do not seem to have yet obtained the status of law.

As for the eradication of the great swathes of existing space debris—in contrast with mere mitigation measures—there is still an open question as to what rules may develop, and this depends on the technology and practices undertaken to eradicate space debris.

6.3.4 Soft Law

The UN Committee on the Peaceful Use of Outer Space (COPUOS) introduced non-binding technical measures in 2007 known as the Space Debris Mitigation

[6] Singer, M.J, & Mussachio, J.T. 2009. Model of an International Environment Agreement among Asymmetric Nations applied to Debris Mitigation. *International Astronautical Congress*. IAC-09. A6.4.11.

Guidelines that were adopted by the UN General Assembly.[7] However, these are not yet legally binding rules, although an argument exists that through continuous use by spacefaring states they can become international customary law. While these guidelines mitigate the increase of space debris, they do not assist in reducing the existing corpus of space debris in orbit. Eradication of space debris is thus still caught in a legal *lacuna*.

Seven guidelines, which are applicable during the "mission planning, design, manufacture and operational (launch, mission and disposal) phases of spacecraft and launch vehicle orbital stages", have been formulated as follows:

- Limit debris released during normal operations;
- Minimize the potential for break-ups during operational phases;
- Limit the probability of accidental collision in orbit;
- Avoid intentional destruction and other harmful activities;
- Minimize potential for post-mission break-ups resulting from stored energy;
- Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low-Earth orbit (LEO) region after the end of their mission;
- Limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit (GEO) region after the end of their mission.

These guidelines are designed to mitigate the further growth of space debris only.

6.4 Shortcomings of the Current Space Debris Regulation Regime

6.4.1 Effectiveness of the Current Space Debris Regulation Regime

The effectiveness of the current SDRR is negatively affected by the fact that the Space Debris Mitigation Guidelines are not binding upon participants in the space industry. This is aggravated by the fact that no global space traffic management system currently exists. At most, the management of the launch of space objects and the orbital management thereof is performed informally by each country and entity by utilising space debris tracking information.

As it stands, it is probable that a significant impact between large space assets may take place releasing even more debris and increasing the chances of a cascading cycle of debris growth and harm. The importance of ensuring, through new rules, that this does not happen is therefore of the utmost importance.

[7] Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, *United Nations Office for Outer Space Affairs*, 2010, http://www.unoosa.org/pdf/publications/st_space_49E.pdf (accessed on 19 December 2017).

The SDRR's current shortcomings can be summarised in that it forms part of the FGSL tainted by the uncertainty of interpretation of the hard law, and the non-compulsory nature of the soft law. Against the background of the growing probability of damage due to space debris, the emergence of a new set of binding laws that forms part of the SGSL is growing in urgency.

6.4.2 New Technology, Opportunities and Business Models

New technological developments are resulting in a burgeoning of ideas, research, plans, and business models to build, launch, and use space debris eradication technologies and vehicles in space to start decreasing the volume of orbital spaced debris. However, the launch and use of any of these technologies will be performed against the background of the uncertainty of the FGSL, as set out *supra*.

It is not the purpose of this paper to enumerate all the projects currently in progress, but rather to provide a systematic framework within which to understand the technology to provide guidance for the establishment of legal certainty and new law. In this regard, reference can be made to the work of Van Wyk to establish a unifying code for technology.[8] Van Wyk has taken the emergence of key concepts that describe the three fundamental aspects of physical reality, namely matter (M), energy (E) and information (I), and used it to "connect all technologies, and to present them in a coherent matrix".

In this regard Van Wyk has devised the very useful nine-cell functional classification matrix as a tool to classify technology along a vertical and a horizontal axis. The vertical axis represents the key aspects of physical reality, and the horizontal axis represents the three modes of technological activity, namely Process, Transport and Store. These three modes of technological activity can be described as follows:

- "Process" entails "inputs of one kind and transforming them into outputs of another kind".
- "Transport" entails "receiving inputs and moving them a certain distance before releasing them".
- Lastly, "Store" entails "receiving inputs and holding them for a period before releasing them".

The technology classification matrix is presented in Table 6.1.

A sample analysis using the technology classification matrix of space transport technology is presented in Table 6.2. Note that the subsystems of space transport technology can each be subjected to this analysis and that the analysis can also be scaled up to larger units or scaled down to smaller sub-units, if applicable.

[8] Van Wyk, R. 2004. *Technology – A Unifying Code*. Cape Town: Stage Media Group.

Table 6.1 Technology classification matrix

		3 modes of technological activity		
		Process	Transport	Store
3 key aspects of physical reality	Matter (M) Energy (E) Information (I)			

Table 6.2 Technology classification matrix of space transport technology

		3 modes of technological activity		
		Process	Transport	Store
3 key aspects of physical reality	Matter (M)	Single- or multi-stage rockets with stages discarded during launch	Rockets (by way of rocket engines) into orbit	Rockets with payloads
	Energy (E)	Internal process in rocket engines and electronic circuitry	Fuel transport by way of fuel tanks and rocket propulsion by way of chemical ignition	Fuel tanks and batteries
	Information (I)	Electronic circuitry and communication systems	ICT systems and software	ICT systems and software

For the purposes of this investigation, the technology classification matrix was adapted to include application of related legal fields, as presented in Table 6.3. This analysis is performed by making use of the Deutsche Orbitale Servicing Mission (DEOS) project—Germany's on-orbit servicing satellite concept. The concept consists of a service satellite used to find unused or decommissioned satellites that could not deorbit and then to rendezvous with the satellite, capture and deorbit it manually. The service satellite will capture the unused satellite by way of a lightweight manipulator or robotic arm and then steer itself and the captured satellite into a predefined re-entry corridor for atmospheric burnup.[9]

Table 6.3 provides a legal-technological analysis of the DEOS service satellite.

Table 6.3 presents a first attempt to design a legal-technological framework that not only sets out the applicable space law in relation to the purpose of the project, but also assists in identifying the applicable legal fields that will become relevant in relation to the various components identified under the three activities of process, transport and store.

This framework also assists in coming to a conclusion on the status of the SDRR and applicable law for the project in that the 'micro' law of contracts provides more certainty than the 'macro' law.

While this framework was developed for the enquiry with regard to the SDRR, it can be applied to any space activity.

[9] Deutsche Orbitale Servicing Mission, *Deutsches Zentrum für Luft- und Raumfahrt e.V.*, (Undated), http://robotics.estec.esa.int/ASTRA/Astra2011/Presentations/Plenary%202/04_wolf.pdf (accessed on 19 December 2017).

Table 6.3 Technology and legal classification matrix for a Space Debris Eradication project

		3 modes of technological activity			Space law related to purpose
		Process	Transport	Store	
3 key aspects of physical reality	Matter (M)	Service satellite launch	Space propulsion rockets and robotic arm for the client satellite	Robotic arm for the client satellite	FGSL 'Macro' law (Hard Law): Uncertain 'Micro' law (Soft Law): the Space Debris Mitigation Guidelines BUT nothing on space debris removal as yet. 'Micro' law (contracts) will have to manage uncertainties.
	Energy (E)	Internal process in space propulsion rockets and electronic circuitry and energy capture by solar cells	Fuel transport by way of fuel tanks and rocket propulsion by way of chemical ignition	Propulsion fuel tanks and batteries	
	Information (I)	Electronic circuitry and communication systems via geostationary satellite feed	ICT systems and software	ICT systems and software	
Other law		**Matter:** Launch agreement **Energy:** Design and manufacture agreement plus intellectual property rights **Information**: Geo-satellite use agreement	**Matter:** Design and manufacture agreement plus intellectual property rights **Energy:** Fuel acquisition agreement **Information**: ICT design and build -agreement; software licensing or development agreement	**Matter:** Design and manufacture agreement plus intellectual property rights **Energy:** Design and manufacture agreement plus intellectual property rights **Information**: ICT design and build agreement; software licensing or development agreement	

6.4.3 New Law and New Ideas?

This enquiry has established that the certainty needed for the future development of space opportunities and the expansion of the space economy has not quite been established. While there seems to be an unwillingness to amend or create new treaties at this stage, there is willingness to establish soft law, as evidenced by the Space Debris Mitigation Guidelines.

As indicated *supra*, the Space Debris Mitigation Guidelines are limited to the mitigation of the further growth of space debris only. What is needed, therefore, is the development of a new set of guidelines to manage space debris removal so that projects such as DEOS are not financed, developed, and launched in a legal vacuum. As may be the case with the Space Debris Mitigation Guidelines, they may also develop into customary international law, and with the increase of space activity, might do so in a short space of time. Thereafter, codification should not lie too far ahead in the future. This new law will form part of the developing SGSL that will need to cater for the New Space era in a fair and equitable manner without inhibiting private enterprise.

For now, in the absence of 'macro' law certainty, the 'micro' law tools of contract will play an increasingly important role to bring, at the very least, legal certainty, *inter se,* between parties that are engaged in space debris mitigation and/or eradication. It is not ideal, but the fast-moving commercial space industry will not let a legal *lacuna* hold back its activities as witnessed by the growing New Space environment.

It is treaty law that all states have the right to access and use of space. If space debris remains an obstacle to exercising this right without proactive legal intervention, it may well happen that self-help and contractual relationships will become the new *de facto* space law. When this occurs, it may too late to play catch up with new treaties as new settled practice will have crystalised into customary international law.

New and innovative ideas must also be sought to deal with the growing and dangerous problem of space debris. One idea that might find traction over time is to build an international launch and orbital tax into the system to ensure joint international action can be funded to eradicate space debris from orbit, akin to the rehabilitation fund that every mine in South Africa must establish to ensure that rehabilitation takes place.

6.5 Conclusion

The new perspective of space law with its 'macro' and 'micro' law delineation, on the one hand brings to the fore the importance of the necessary legal certainty that will be provided by 'micro' law tools if the 'macro' law is not developing fast enough. On the other hand, the delineation between the First Generation space law

and the Second Generation space law underscores the fact that new space law needs to be developed to provide certainty and an adequate framework to deal fairly and in an enabling manner with the burgeoning New Space world.

The analysis of the Space Debris Regulatory Regime underscores the conclusion that new law needs to be developed faster. Given the complexities of law enactment in international law, it is sensible to start off with soft law development that might turn into customary international law fairly quickly due to its fast adoption rate in practice, hopefully followed by codification per treaty.

The technological nature of space law requires it to have not only legal understanding, but also insight into the technologies that enable space activities. In this regard, the technology classification matrix, as adapted into the legal-technological framework, may be useful in establishing the applicable law for space projects. It can be further refined as situations require, but is at the very least a starting point for a legal-technological analysis. The analysis *in casu* making use of the framework has also indicated the lack of certainty in hard law and the fall back on soft law.

In essence, this enquiry has raised more questions than answers. The questions deserve a quick response in the absence of which the space industry will cut its own path that could in the long run lead to inequitable outcomes and new dangers to the global commons.

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Chapter 7
Proposal for an International Agreement on Active Debris Removal

Zhuang Tian

Abstract Along with the benefits derived from space applications, the burgeoning of space activities has also shown a side effect, namely numerous pieces of space debris orbiting the Earth. Awareness of the problem of space debris has been raised and spread with the increasing severity of this issue, and many initiatives have been taken. This note deals with several legal questions concerning the implementation of Active Debris Removal (ADR). The first question is what should be removed, i.e., the definition of the term "space debris", and the correlation between this term and the term "space object" which is frequently referred to in the United Nations (UN) space treaties.

The UN space treaties are commonly referred to as the "five United Nations treaties on outer space" which are:

(i) Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies 18 UST 2410 (1967) (Outer Space Treaty);
(ii) Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Rescue Agreement);
(iii) Convention on International Liability for Damage Caused by Space Objects 672 United Nations Treaty Series 119 (1968) 24 UST 2389 (1972) (Liability Convention);
(iv) Convention on Registration of Objects Launched into Outer Space 28 UST 695 (1975) (Registration Convention); and
(v) Agreement Governing the Activities of States on the Moon and Other Celestial Bodies 1363 Nations Treaty Series 3 (1979) (Moon Agreement).

Texts of all of these treaties can be found at <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html>

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The following question is who can remove space debris, and subsequently the potential liabilities involved in such implementation. Finally, this note discusses the establishment of an Orbital Maintenance Fund for the promotion of technological development in ADR.

7.1 Introduction

Space science and space applications improve our fundamental knowledge of the-universe and the daily lives of people worldwide through environmental monitoring, management of natural resources, early warning systems to help mitigate disasters and support disaster management, meteorological forecasting, climate modeling, and satellite navigation and communications.[1] Therefore, space science and technology make a major contribution to the well-being of humanity, supporting the goals of major UN conferences and summits and playing a vital role in various aspects of economic, social and cultural development on Earth.[2] Along with the benefits derived from space applications, the burgeoning of space activities also brings about a hazardous side effect, i.e., numerous pieces of space debris orbiting the Earth, which pose threats not only to space objects and astronauts therein but also to persons and property on the ground.

The condition of the space environment is worsened by the self-generating effects of space debris. In 1978, NASA scientist Donald J. Kessler proposed a theory which was now known as the "Kessler Syndrome". According to Kessler, as the number of artificial satellites in earth orbit increases, the probability of collision between satellites also increases.[3] Satellite collisions would produce orbiting fragments, each of which would increase the probability of further collisions, over time resulting in an exponential increase in the number of objects, and thus leading to the growth of a belt of debris around the Earth.[4] Recent studies on the instability of the debris population in the LEO indicate that the environment has reached a point where collisions among existing objects will cause the LEO population to increase, at least in the next 200 years, even without any new launches.[5] In reality, the situation will be worse than this "no future launches" scenario, since satellite launches

[1] UN Doc. A/AC.105/L.308, Guidelines for the long-term sustainability of outer space activities (15 February 2017), at 11. *See* http://www.unoosa.org/oosa/oosadoc/data/documents/2017/aac.105l/aac.105l.308_0.html.

[2] *Id.*

[3] Donald J. Kessler and Cour-Palais B. G. *"Collision frequency of artificial satellites: The creation of a debris belt."* Journal of Geophysical Research: Space Physics 83, No. A6 (1978): 2637.

[4] *Id.*

[5] J.C. Liou, *"An Active Debris Removal Parametric Study for LEO Environment Remediation."* Advances in Space Research 47, No. 11 (2011): 1865.

will continue and unexpected major breakups may continue to occur.[6] This conclusion has also been confirmed in the UN Report on ADR and OOS, which states that,

> While a population of about 2,500 intact objects in LEO may be considered the threshold of stability beyond which the amount of debris in LEO will continue to increase by itself, estimates show that this threshold of stability has already been surpassed with the current number of intact objects in LEO reaching 2,683.[7]

According to Gunnar Leinberg, with the present rate of growth of orbital space debris, it is only a matter of time before the debris becomes a serious impediment to space operations.[8] Without proper international controls, the continuing accumulation of orbital space debris will eventually prevent man from being able to utilize outer space.[9]

Awareness of the problem of space debris has been raised and spread with the increasing gravity of this issue, and many initiatives have been taken. The European Space Agency (ESA) is now planning an active debris removal mission, eDeorbit, whose goal is to capture a heavy, ESA-owned item of debris and remove it from an altitude of 800–1000 km in a near-polar orbit.[10] Likewise, China has launched Aolong-1 (the Roaming Dragon, in English), a space debris clean-up satellite, on the inaugural Long March 7 flight in June 2016.[11] This space "garbageman" is equipped with a small robotic arm to grab debris pieces and launch them towards the atmosphere for de-orbiting.[12]

However, although several IADC member agencies are now actively working on various orbital debris removal concepts, routine operations to remove orbital debris will likely not occur for several years to come.[13] Moreover, it is generally agreed that in addition to the technical challenges of debris removal, many economic and legal hurdles also exist.[14] The economic hurdle concerns mainly the question of who should pay for the cost of the operation of ADR missions. The legal hurdles include but are not limited to: (1) lack of a legally binding definition of space debris; (2) possible

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[6] *Id.*

[7] UN Doc. A/AC.105/C.1/2012/CRP.16, *"Active Debris Removal — An Essential Mechanism for Ensuring the Safety and Sustainability of Outer Space, A Report of the International Interdisciplinary Congress on Space Debris Remediation and On-Orbit Satellite Servicing."* (27 January 2012) (referred to in this note as the Report on ADR and OOS) at 20. *See* http://www.unoosa.org/pdf/limited/c1/AC105_C1_2012_CRP16E.pdf.

[8] Gunnar Leinberg, *"Orbital Space Debris."* 4 J.L. & Tech. (1989): 93.

[9] *Id.*

[10] ESA, *"E.Deorbit: It is Time to Make Active Debris Removal a Reality for The European Space Sector."* (2017) *See* http://blogs.esa.int/cleanspace/2017/01/30/e-deorbit-it-is-time-to-make-active-debris-removal-a-reality-for-the-european-space-sector.

[11] Ajey Lele, *"China's 2016 Space White Paper: An Appraisal."* (2017) *See* http://www.eurasiareview.com/09012017-chinas-2016-space-white-paper-an-appraisal.

[12] *Id.*

[13] IADC Steering Group,*"Space Debris - IADC Assessment Report for 2011."* (2012) at 17. *See* http://www.iadc-online.org/Documents/IADC-2012-06,%20IADC%20Annual%20Report%20for%202011.pdf.

[14] *Id.*

infringement upon other states' sovereign jurisdiction or ownership as inactive or dead space objects are generally believed to remain space objects; (3) possible liability for damage caused in ADR operations; and (4) concern for the inherent Anti-Satellite (ASAT) potential due to the dual-use nature of some types of ADR systems.[15] As noted by Brian Weeden, further technical research and development on ADR techniques and technologies is required and is underway by scientists and engineers around the world.[16] Meanwhile, the legal and policy issues are no less important, and policymakers and lawyers should thus begin tackling the non-technical challenges.[17]

When the UN space treaties were drafted, the hazard of space debris had not yet been envisaged. As a consequence, these treaties contain only vague and general provisions concerning space environment protection, among which many articles are subject to divergent interpretations.[18] Hence, these treaties are not the most practical tools to confront the challenges posed by space debris. Meanwhile, international soft laws contain more specific rules on space debris. However, these rules have their limitations. First, they are non-legally binding and thus cannot impose any compulsory obligation on states. Second, the soft laws most relevant to space debris, including the Inter-Agency Space Debris Coordination Committee Space Debris Mitigation Guidelines (IADC Guidelines) and the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space Guidelines (COPUOS Guidelines), apply mainly to debris mitigation; debris remediation is not a focus of these guidelines.[19] Therefore, specific legally binding rules in this regard

[15] Jinyuan Su, *"Active Debris Removal: Potential Legal Barriers and Possible Ways Forward."* Journal of East Asia and International Law 9, no. 2 (2016): Chapter II.

[16] Brian Weeden, *"Overview of the Legal and Policy Challenges of Orbital Debris Removal."* Space Policy 27, no. 1 (2011): 42.

[17] *Id*. at 43.

[18] For instance, there are different interpretations of the term "harmful contamination" as prescribed in Article IX of the Outer Space Treaty. *See* Roberts, Lawrence D, "*Addressing the Problem of Orbital Space Debris: Combining International Regulatory and Liability Regimes."* Boston College International and Comparative Law Review 15, No. 1 (1992): 61. Howard A. Baker has asserted that "harmful contamination" must be interpreted from a reading of Article IX as a whole, and it was never intended that the protection offered by this article would apply to the environments of outer space, the Moon and celestial bodies *per se*. *See* Howard A. Baker, *"The Sci-Lab Perception: Its Impact on Protection of the Outer Space Environment."* Proceedings of the Thirtieth Colloquium on the Law of Outer Space (1987): 127. On the contrary, M. Miklody maintains that this term was intended to protect the sanctity of the space environment itself irrespective of any human activity therein. *See* M. Miklody, *"Some Remarks to the Legal Status of Celestial Bodies and Protection of Environment."* Proceedings of the Twenty-fifth Colloquium on the Law of Outer Space (1982): 13.

[19] However, it should be noted that debris remediation is one of the major concerns of the proposed second set of Guidelines for the long-term sustainability of outer space activities, which are still under discussion. *See* UN Doc. A/AC.105/C.1/L.362 (21 June 2017). Work continues on this second set of guidelines, which will be brought together with the first set to form a full compendium of guidelines. The full compendium will then be referred to the General Assembly in 2018. *See* http://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html.

are required. As such, the main purpose of this note is to discuss the establishment of an international treaty on ADR.

This note is divided into seven sections. Section 7.1 gives a general overview of the problem of space debris from a technical and legal perspective. Section 7.2 presents the overall background for the establishment of an international regime regulating space debris. The main body of this note lies from Sects. 7.3 to 7.6, which discusses the elements to be considered for the establishment of such an agreement. These include the definition of the term "space debris", the potential resolution of the hurdle arising from the jurisdiction and control provision of the Outer Space Treaty, the establishment of an international Orbital Maintenance Fund for relevant technological developments, and the potential liability issues involved in the implementation of ADR. Section 7.7 concludes this note.

7.2 Overall Background for the Establishment of an International Agreement on ADR

Before discussing the content of a potential international agreement on ADR, a general analysis of the overall background will be made to lay a foundation for the following discussions. This analysis includes an examination of the obstacles to the implementation of ADR, an analysis of the remediation of space debris from a game theory perspective, and a discussion on the most appropriate forum for the international negotiation of such an agreement.

7.2.1 Obstacles to the Conduct of ADR

With regard to an analogous problem, the one of global climate change, scholars have argued that,

> The greatest obstacles to resolving the threat of long-term climate change remain social and political, rather than financial or technical. These problems have, in the past, proven to be intractable because the gains from environmental exploitation are immediate and certain and they accrue to the exploiters, while the benefits of environmental amelioration are in the more distant future, are less certain, and are diffuse, that is, shared with the entire population rather than being retained by those who make the effort to reduce their environmental impacts. Adding to the complexity is the need to coordinate activities among numerous companies, numerous national governments, numerous trading blocs, and numerous populations.[20]

[20] Eric K. Clemons and Heinz Schimmelbusch. *"The Environmental Prisoners' Dilemma Or We're All in This Together: Can I Trust You to Figure it Out?"* (2007) at 1. *See* http://opim.wharton.upenn.edu/~clemons/blogs/prisonersblog.pdf.

The resolution of the space debris problem encounters similar obstacles. Moreover, whereas the solution to the problems of global warming and long-term climate change is both economically and technologically feasible,[21] which is not the case for ADR, as ADR implementation is expensive and the technology is not yet mature. Furthermore, two obstacles stand in the way of an international agreement on ADR: the externalization of the costs and benefits, and the absence of short-term cost-effective returns.

7.2.1.1 Externalization of Costs and Benefits

The externalization of costs and benefits may trigger the "tragedy of the commons" phenomenon. A classic model of the tragedy of the commons, the "herdsman in the pasture" model, as presented by Garrett Hardin, can be referred to as an illustration.

> Picture a pasture open to all. […] As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, 'What is the utility to me of adding one more animal to my herd?' This utility has one negative and one positive component.
>
> 1) The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1.
>
> 2) The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision-making herdsman is only a fraction of -1.
>
> Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another… But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit — in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.
>
> […]
>
> In a reverse way, the tragedy of the commons reappears in problems of pollution. Here it is not a question of taking something out of the commons, but of putting something in —sewage, or chemical, radioactive, and heat wastes into water; noxious and dangerous fumes into the air, and distracting and unpleasant advertising signs into the line of sight. The calculations of utility are much the same as before. The rational man finds that his share of the cost of the wastes he discharges into the commons is less than the cost of purifying his wastes before releasing them. Since this is true for everyone, we are locked into a system of 'fouling our own nest,' so long as we behave only as independent, rational, free-enterprisers.[22]

[21] *Id*.

[22] Garrett Hardin, *"The Tragedy of the Commons."* Science, Vol. 162, No. 3859 (1968): 1244–1245.

In the herdsman scenario, the cost of pollution has been externalized, namely every herdsman is only affected by a fraction of his overuse of the pasture. The situation of space debris is similar to the problem of pollution mentioned above, while this time the population does not consist of people but space objects, and the pollution does not concern air or water pollution but space debris.

7.2.1.2 Lack of Short-Term Cost-Effective Returns

Another difficulty for the establishment of an international agreement on ADR is the lack of short-term cost-effective returns of ADR. In the short term (i.e., over the next 20–30 years), ADR will have minimal apparent benefit to operating satellites, because the principal effect of debris is degradation of satellite lifetime due to small debris impacts on solar panels—effects that can be fairly easily minimized through improvements in solar panel design.[23] Also, as collision avoidance services mature, there have only been a few collisions involving operating satellites and large debris.[24] The primary benefit of active debris removal will be realized only in the long term, as it will reduce the possibility of uncontrolled debris growth and future limitations on space operations.[25]

Meanwhile, it has been argued that politicians' incentives are far more short-sighted, and there is a cornucopia of examples of government short-termism at the expense of the future.[26] This argument is based on the analysis that "an election loser will be out of office, and capture no appreciable benefit from efforts invested. So when an upcoming election is in doubt, everything goes on the auction block to buy short-term political advantage."[27] Such government short-termism can be further explained by the presidential term limits as enshrined in the constitutions of many states, as non-consecutive terms in office would drive the short-term behavior of governments. That is a reason why in 2016 the then South Korean President Park Geun-hye proposed amending South Korea's constitution to end the single term limit, as "through the single-term presidency, it is difficult to maintain policy continuance, see results of policy and engage in unified foreign policy."[28] The government short-termism is incompatible with the long-term benefits of debris remediation and thus constitutes an obstacle to the development of ADR.

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[23] Report on ADR and OOS, *supra* note 9, at 28.

[24] *Id*.

[25] *Id*.

[26] Gary Galles, *"Politicians Seek Short-Term Advantages by Lecturing Capitalists about the Long Term."* (2015) *See* https://mises.org/library/politicians-seek-short-term-advantages-lecturing-capitalists-about-long-term.

[27] *Id*.

[28] Kim Gamel, *"S. Korean president proposes amendment to end single-term limit."* (2016) *See* https://www.stripes.com/news/s-korean-president-proposes-amendment-to-end-single-term-limit-1.435542.

7.2.2 Analysis from a Game Theory Perspective

Simply put, the current debris pollution situation can be summarized in one sentence, "the cost of 'environmental bad behavior' and continued pollution is borne by everyone in the long run, while the benefits are enjoyed by the polluter immediately."[29] It can be argued that all spacefaring states are aware of the importance of ensuring the sustainability of outer space environment, as well as the necessity to mitigate and remediate space debris, but what hinders them from actively taking actions is that all these states are in a setting "in which unilateral good behaviour is actually expensive, and bilateral good behaviour is not certain to occur".[30]

This setting is similar to the"prisoner's dilemma" setting, with two major differences. First, unlike the prisoner's dilemma setting, where prisoners cannot talk before making their decisions, states do not have to make their decisions without discussions.[31] Hence, a first step towards the conclusion of an international agreement on debris remediation is to carry out international conversations, especially among spacefaring nations who are both the major contributors to space debris and the most technically capable subjects to implement ADR, in which states can thoroughly exchange their concerns and declare their commitments. Second, states can play the game repeatedly, year after year.[32] The repeated prisoner's dilemma may be solved with a very simple "tit-for-tat" strategy: play nice after your playing partner has been nice, and play nasty after your partner has been nasty.[33] What needs to be considered is how to ensure that such a "tit-for-tat" strategy will not deteriorate into a "race to the bottom", which would render outer space inaccessible, with the whole international community being the ultimate victim. To maintain a gentleman's club, an "assisted tit-for-tat" or "tit-for-tat with a referee" strategy appears to be a plausible option, where sufficient pressure is put on major polluting nations to alter their behavior.[34] Hence, an international agreement has to be established to settle potential disputes and to punish players who unreasonably benefit themselves at the cost of the whole international community.

7.2.3 Forum for Negotiation

It has been argued by Lotta Viikari that the creation of a treaty promulgated through the UN to address the problem of space debris would prove to be ineffective because a consensus between all of the spacefaring nations would be very time-consuming

[29] Clemons, *supra* note 22, at 9.

[30] *Id*.

[31] *Id*. at 6.

[32] *Id*.

[33] *Id*. at 11.

[34] *Id*. at 12.

and would most likely result in a watered-down resolution.[35] Time-consuming as it might seem, a systematic regulatory regime is indispensable for solving the intricate legal challenges that may emerge in the process of ADR implementation. These challenges include jurisdiction and control, funding, and liability, which will be analyzed in the following discussions. Bearing in mind the necessity of a legally binding agreement in this regard, the longer it takes to reach such an agreement, the earlier the efforts in this direction should be made to nip in the bud the emerging Kessler effect of space debris.

Christopher D. Williams argues that it would be advantageous to pursue multilateral negotiations and discussions among active space nations rather than seek action through an existing organization.[36] Emphasis should be put on spacefaring nations because participation by all, or even a large number of states, could result in needless waste and delay, as "only those states which are involved in space activities can take an action to contain the production of space debris, and only those states can suffer from damage to space objects caused by debris."[37] Gathering a group of stakeholders focusing solely on the issue of space debris would increase the efficiency of discussion, and efforts at negotiation should be continued with the goal of an international agreement firmly in mind.[38]

In brief, the legal challenges in the way of ADR implementation justify the necessity of reaching an international agreement in this regard. Without such an agreement, states would have less incentive to implement ADR, as the benefits thereof are mostly externalized and in the long term. The necessity can also be argued from a game theory perspective with the analysis of the classical prisoner's dilemma model. The following sections will discuss the key elements for an international agreement on ADR, including the definition of space debris, the effect of the jurisdiction and control provision, the establishment of an international fund, and the liability issues. It should be noted that this note is not intended to be exhaustive in this regard, and there are other elements which may also require the attention of the international community when discussing and negotiating an international agreement on ADR.

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[35] Lotta Viikari, *"The Environmental Element in Space Law: Assessing the Present and Charting the Future."* Brill, 2008: 100. *See also* Plantz, Meghan R. *"Orbital Debris: Out of Space."* Ga.j.intl & Comp.l 2(2013): 608.

[36] Christopher D. Williams. *"Space: The Cluttered Frontier."* J.air L. & Com (1994): 1182.

[37] Jürgen Reifarth, *"An Appropriate Legal Format for the Discussion of the Problem of Space Debris."* Environmental Aspects of Activities in Outer Space (Karl-Heinz Böckstiegel ed., 1990): 308. Williams, *id*. at 1181–1182.

[38] William, *id*. at 1183.

7.3 Definition of Space Debris

7.3.1 Function-Based Approach and Control-Based Approach

There is no binding definition of the term "space debris" or "orbital debris" in the UN space treaties. In addressing the question of when can a space object be regarded as space debris, I. Ph. Diederisks Verschoor stated that "current opinion in international organizations tends to assume that an object is debris when all the fuel has been used up and the object can no longer be controlled."[39]

Consequently, there seems to be a relevant connection between control of a space object and its nature as debris.[40] Such criterion might encounter problems when CubeSats come on the scene, as a large proportion of these satellites do not have propellants on board and therefore lack maneuverability. Following the control-based criterion, these CubeSats would be categorized as space debris, which is an inappropriate classification as they also serve important functions. Hence, if the term "control" equates with the maneuverability of a space object, then it should not be referred to as a criterion for the determination of space debris.

Reference can be made to the Decree of 19 January 2015 expanding the scope of the Space Activities Act to include the control of unguided satellites (Unguided Satellites Decree) of the Netherlands.[41] Article 1 of the Unguided Satellites Decree provides that the Space Activities Act also applies to the control from the Netherlands of an unguided space object in outer space by means of a communications link. It appears that the term "control" is interpreted as including the "communication connection". Following this interpretation, most CubeSats are controllable and would thus fall outside the scope of the term "space debris". However, such communication connection criterion has its limits as this rule may be circumvented. States may intentionally install on space objects some long-lasting communication units which will remain operational even after such objects become otherwise non-functional, and thus these objects would never be categorized as space debris unless their communication units are damaged.

In 1999, the Scientific and Technical Sub-Committee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) adopted a "*Technical Report on Space Debris*".[42] The report proposed a definition of the term "space debris" that "space debris are all manmade objects, including their fragments and

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[39] I. H. Ph. Diederiks-Verschoor, *"An introduction to space law."* 2nd ed. The Hague: Kluwer, 1999. p. 131. Olavo de O. Bittencourt Neto, *"Chasing Ghost Spaceships: Law of Salvage as Applied to Space Debris."* Proceedings of the International Institute of Space Law (IISL) 2014: 154.

[40] Bittencourt Neto, *id*.

[41] *See* http://www.unoosa.org/documents/pdf/spacelaw/national/Netherlands_BZ116174A.pdf. *See also* Neta Palkovitz and Tanja Masson-Zwaan. *"Orbiting under the Radar: Nano-Satellites, International Obligations and National Space Laws."* Proceedings of the IISL 2012.

[42] UN Document A/AC.105/720 (1999).

parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized."[43] It was recognized in the report that there was still no consensus agreement on the definition.[44]

Space debris is defined in the IADC Guidelines as "all man-made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non functional." The same definition can be found in the COPUOS Guidelines. The technical definition of space debris, endorsed by these guidelines, focuses on the functionality or otherwise of space objects as the relevant criteria for distinguishing between space objects and space debris.[45] Thus, according to the technical definition, if a space object is functional, it is not space debris and *vice versa*.[46]

Compared to the control-based criterion, the function-based one better reflects the characteristics of space debris, as not all non-controllable space objects are space debris, especially those functional but non-maneuverable. Moreover, when non-functional space objects are to be categorized as space debris, states would be less likely to conceal the functions of their space objects. Furthermore, states would be stimulated to use multi-functional space objects, for by this means the completion of one function would not directly render a space object to be regarded as non-functional, which would then improve the use-efficiency of outer space.[47]

However, to be categorized as space debris from a technical perspective does not equate with to be regarded as derelict from a legal perspective as space objects that are outwardly non-functional may still have a legal value.[48] In other words, space debris does not always qualify as "space waste".[49]

Attention should also be paid to the wording "in Earth orbit or re-entering the atmosphere", according to which space debris seems to be better understood as "orbital debris". Indeed, space is immense. From the human perspective, space might be infinite, but not all space is created equal.[50] Limitless outer space will never be as valuable to humans for communications, research, and defense as the Earth's own orbit.[51] Earth orbit is a limited, precious resource and has no conceivable substitute.[52] Hence, when using the term "space debris", it should be borne in

[43] *Id*. para.6.

[44] *Id*.

[45] Report on ADR and OOS, *supra* note 9, at 30.

[46] *Id.* at 30–31.

[47] The use of multitask satellites is likely to minimize the number of man-made objects orbiting the Earth as fewer satellites are needed to undertake tasks.

[48] Report on ADR and OOS, *supra* note 9, at 31.

[49] *Id*.

[50] Natalie Pusey. *"The Case for Preserving Nothing: The Need for a Global Response to the Space Debris Problem."* Colo. J. Int'l Envtl. L. & Pol'y 21 (2010): 449.

[51] *Id*.

[52] *Id*.

mind that at the current stage this term refers mainly to debris orbiting Earth or re-entering the atmosphere. With the extension of human activities into deep space, a geographically broader understanding of the term "space debris" would then be considered.

7.3.2 Correlation Between Space Debris and Space Object

None of the UN space treaties deal directly with the problem of orbital debris, and the term "debris" is not even mentioned in these treaties. Rather, The UN space treaties use the term "space object" to regulate space activities. However, this term is not clearly defined in the treaties. According to the Liability Convention and the Registration Convention, a space object includes component parts of a space object as well as its launch vehicle and parts thereof.[53] The fact that the definition of space object includes the term "space object" reveals how circular the analysis in this area can become.[54]

The manner in which debris is defined will have an impact not only on any future agreement but also on the current UN space treaties.[55] If debris is not within the scope of the term "space object", then the provisions of the Registration Convention and the Liability Convention will not apply.[56] On the contrary, if space debris is a constituent category of space objects, then certain liability implications will arise for certain states if the damage is caused by the removal of debris from space.[57] Also, many complex questions relating to state jurisdiction and control over space objects will have to be resolved before the commencement of any removal.[58] Hence, the correlation between the terms "space debris" and "space object" is beyond the scope of academic discussion and is of important practical relevance.

Christopher D. Williams advocates the exclusion of the term "orbital debris" from the term "space object". According to Williams,

> Clearly, removing debris from the scope of the Outer Space Treaty and Registration and Liability Conventions could have several positive effects if done in conjunction with the development of an intelligible set of guidelines concerning debris. First, such removal would do away with the contradictory and confusing arguments put forth by commentators. (…) Second, the existing international outer space agreements were clearly not intended to address the problem of space debris. (…)[59]

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[53] Art. I (d), the Liability Convention. Art. I(b), the Registration Convention.

[54] Williams, *supra* note 38, at 1147–1148.

[55] *Id*. at 1184.

[56] *Id*.

[57] Report on ADR and OOS, *supra* note 9, at 30.

[58] *Id*.

[59] Williams, *supra* note 38, at 1184–1185.

If space debris is excluded from the definition of the term "space object", it will not be subject to the continuing jurisdiction and control of the state of registry as contemplated by the Outer Space Treaty and Registration Convention. Williams further stated that,

> Although satellite owners might fear the loss of the satellite after the end of its useful life, this definition would provide an incentive to arrange for the proper disposal of the satellite. If the owner had not done so, then it could not complain about the later removal of the debris.[60]

It is true that under this arrangement, the legal hurdle contained in Article VIII of the Outer Space Treaty can be overcome. However, the fear of loss of satellite after the end of its useful life could constitute a high barrier to cross for an international consensus on such an arrangement, in that many spacefaring states may not be willing to surrender their jurisdiction and control over their space assets even after such assets become space debris. As noted by some scholars, "those wandering vessels cannot be properly considered *res derelict* since, more often than not, their jurisdiction is legally and continuously safeguarded against third parties, due to their strategic importance."[61]

Moreover, it has become a common understanding that at least some debris falls within the scope of the term "space object". Tanja Masson-Zwaan is of the opinion that logically, an inactive satellite or even a lost screwdriver should still be regarded as (a component part of) a "space object" for which responsibility and liability remain with the launching state should damage occur.[62]

Though at least some space debris such as inactive satellites shall be categorized as space objects, the legal status of the rest of space debris is less clear. It is the opinion of this writer that the term "space debris" should be completely covered by the scope of the term "space object", for the following three reasons: (1) In such circumstance, the *lex specialis derogat generali* doctrine will apply, and the rules governing space debris agreed upon in the future will override the previous law that generally governs space objects. For matters not regulated under the former, reference can be made to the UN space treaties to fill the legal loopholes; (2) Assuming that some debris is space object while the rest not, a line shall be drawn there between. However, although space debris can be technically classed into four categories—inactive payloads, operational debris, fragmentation debris, and microparticulate matters—such lines are difficult to draw from a legal perspective. For instance, if an inactive payload disintegrates into two halves, should these two pieces be categorized as inactive payload or fragmentation debris? In a more complex situation, e.g., one piece of debris contains the majority mass of the original payload while the mass of the other is almost negligible, or the active payload dis-

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[60] *Id.* at 1185.

[61] Francis Lyall and Paul Larsen. *"Space Law: a Treatise."* Farnham: Ashgate, 2009: 310. Bittencourt Neto, *supra* note 41, at 154.

[62] Tanja Masson-Zwaan, *"Legal Aspects of Space Debris."* IAA Space Debris Situation Report 2016, published in June 2017: 142.

integrates into countless pieces rather than just two, what is the legal status of these debris; and (3) Even if a line can be arbitrarily drawn, why the legal status of space debris should differ, e.g., why damage caused by some debris may trigger the liability of the launching states under the UN space treaties, while damage caused by the rest may not. In brief, space debris shall not be treated differentially from a legal perspective and shall be defined as a proper subset of the term "space object".

7.4 Jurisdiction and Control

Article VIII of the Outer Space Treaty is not pertinent to the creation of debris, but it does have implications for the removal of debris.[63] The first sentence of Article VIII reads,

> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body.

In accordance with this article, the state of registry shall retain jurisdiction and control over such object, irrespective of its *locus* as well as the continuance of its maneuverability or command, and such jurisdictional link is not affected if and when such space object eventually becomes space debris.[64] Article VIII constitutes a serious legal obstacle that needs to be addressed for ADR to become a reality because it can give rise to an eventual denial, by the state with jurisdiction, of any effort to remove from orbit, space debris registered on its behalf, irrespective of its factual condition or situation.[65]

In view of the general rule that a state (or its private entities) cannot remove another state's space object without permission, the fundamental question arises: should states be allowed to remove a space object without obtaining permission from the state on whose registry the space object is carried?[66] If the answer is affirmative, on what basis shall such allowance be made?[67] It appears that the provisions on jurisdiction and control hinder the implementation of ADR. To tackle this challenge, Olavo de O. Bittencourt Neto refers to the prohibition of abuse of rights doctrine. According to Bittencourt Neto, the unjustified denial of other parties' active removal initiatives of dangerous space debris may represent an abuse of rights by the appropriate State.[68] If this doctrine is to be applied, two terms need to be clarified. First, what constitutes an "unjustified denial"? Can the fact that the target space debris contains classified technology, which is the case for most space objects, be

[63] Williams, *supra* note 38, at 1154.

[64] Bittencourt Neto, *supra* note 41, at 158–160.

[65] *Id.* at 158.

[66] Report on ADR and OOS, *supra* note 9, at 33.

[67] *Id*.

[68] Bittencourt Neto, *supra* note 41, at 162.

regarded as a reasoned argument? Second, how the term "dangerous" is to be defined? It can be said that all space debris is to some extent dangerous due to its high velocity while orbiting the Earth or reentering the atmosphere. Hence, the risk involved in space debris is a matter of degree. In this context, can a state argue that its debris is not the most threatening one, and priority of removal should thus be given to other debris?

Bittencourt Neto further argues that "active removal of dangerous, non-functional space objects, remaining in the orbit around the Earth without possibility of manoeuvre or command, would *a priori* be allowed, irrespective of express authorization by the State who enjoys jurisdiction over the referred space object, in order to answer a relevant environmental concern."[69] A similar view can be found in the draft of the second set of LTS guidelines. According to these guidelines, adjustments to the status of space objects under the jurisdiction and control of states and international organizations may, in particular, be validated as an operational necessity with regard to space debris fragments if it is convincingly established that such fragments have irretrievably lost the ability to function or sustain functionality, and that lifting constraints on their removal could be the best solution.[70]

However, it is important to note that the space security nexus to jurisdiction and control over space objects continues *ad infinitum*.[71] Hence, if the above proposals are to be adopted, an intricate system has to be established taking into account the following questions: what is the criterion[72] to determine whether a space debris should be removed; through what procedure; what are the defences that may be raised by the state of registry; who has the final say when a disagreement arises; and what if a wrong space object is taken? These questions have to be carefully dealt with, as hastily circumventing the provisions of the existing regime that establish jurisdiction and control in the state of registry may have negative consequences for space security.[73]

Meanwhile, national legal and regulatory provisions in some states might inhibit the conduct of ADR.[74] The United States International Traffic in Arms Regulations (ITARs) serves as an example. ITARs basically govern the export of defense articles, services, and technical data for items on the U.S. Munitions List, in which spacecraft and associated systems are included in Category XV.[75] Performing ADR of a U.S. satellite or a satellite of another country that has U.S. components or technology on board falls squarely within the definition of "export" under the ITARs,

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[69] *Id*.

[70] UN Doc. A/AC.105/L.308, *supra* note 3, at 31.

[71] Report on ADR and OOS, *supra* note 9, at 33.

[72] It should be noted that the functionality-based criterion as proposed by Bittencourt Neto and in the second set of LTS guidelines embraces a large majority of space debris. Due to the strategic importance of classified technology contained in space debris, it is unlikely that states will agree to renounce their jurisdiction and control over these objects.

[73] Report on ADR and OOS, *supra* note 9, at 33.

[74] *Id*.

[75] *Id*. at 33–34.

which will be either absolutely prohibited or costly.[76] As a result, obstacles for ADR implementation may be derived from both international law and national law.

Under the trend of commercialization and privatization of outer space, a solution is proposed in the Report on ADR and OOS, which is worthy of consideration and adoption for a regulatory framework for space debris. According to this proposal,

> Subscription of governments to concurrently sign an agreement to procure on a commercial basis the removal of space debris created by their own national space activities (e.g., 1 percent per year). Each subscribing country would then be allowed to impose a national space "garbage" collection tax on final users of space-based commercial services available in the country.[77]

National laws such as the U.S. export control regulations as mentioned above may impose restrictions on such procurement. The solution would be either to amend these national regulations or to subscribe to removal services provided by space companies of the same nationality. Other than on a commercial basis, a variation could be a commitment declared by all spacefaring states to remove a certain percentage of space debris created by their previous space activities.

With regard to the percentage of removal, the example given above is "1 percent per year". Several questions ensue: what is the denominator for such percentage—the total amount of debris or the cataloged debris; and what is the basis—the mass, the size, or the number of space debris? Although calculation based on the total amount of debris appears to be the fairest, it is impractical for such calculation to be made as the majority of debris is non-cataloged and some is even untracked due to their tiny physical size. Hence, a proportion based on cataloged debris would be a more feasible option. Meanwhile, the calculation based on the mass and size of space debris would be a more effective option which would motivate states to remove larger debris. It has been argued that if five large objects are removed each year, the cascading effect predicted by Kessler can be halted.[78] In addition, the destructive effect of larger debris is normally greater than that of the smaller debris. It should also be noted that "per year" as a period may not be long enough, for the preparatory arrangement and practical implementation of ADR normally require more than a year. Hence, it is more realistic to set a longer period such as "per five years" or "per decade".

7.5 Orbital Maintenance Fund

Agatha Akers proposes an amendment to the 1975 Registration Convention to establish an Orbital Maintenance Fund endowed by a space access fee in order to create general resources to finance the development of new technology needed to

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[76] *Id*.

[77] *Id*. at 39–40.

[78] *See "Stability of the Future LEO Environment"*, an IADC study presented to UNCOPUOS, February 2013, available at http://www.unoosa.org/pdf/pres/stsc2013/tech-12E.pdf. *See also* Masson-Zwaan, *supra* note 64, at 144.

clean up orbital space.[79] An analogy can be made to the yearly fees paid by United States drivers when cars are registered to maintain highways.[80]

This note shares the opinion of Agatha Akers that an Orbital Maintenance Fund shall be established. To avoid reinventing the wheel, resources should be pooled to promote technological development to ensure the cost-effectiveness and safety of the implementation of ADR. Another benefit of pooling resources and enhancing cooperation for technological development is that when technologies are shared, the concerns of states over the dual-use nature of ADR technology can be alleviated.

However, such a Fund should not be established by amendment to the Registration Convention—a new treaty is needed to deal with this issue, for two reasons. First, the primary concern of the Registration Convention is the registry of space objects rather than dealing with the problem of space debris. Second, there are many questions that need to be approached including who is the payer, on what basis shall the funds be collected, the use of the funds and its management, the dispute resolution measures, etc. It is more advisable for these issues to be addressed in a systematic framework.

The mechanism of fund collections is the first issue to be addressed. As a general rule, the state or entity (i.e., principal space system procurers, developers and operators) responsible for creating space debris should bear primary responsibility for its proper disposal.[81] However, to require a lump sum payment of the major spacefaring nations for the existing debris is neither a fair nor a plausible option. First, spacefaring nations are not the sole beneficiaries of the use and exploration of outer space. Satellite constellations such as the US Global Positioning System (GPS), weather satellites and other spacecraft, constitute significant global "social infrastructure" that provides immense benefits to the world at large, not only to the spacefaring nations that are responsible for their launching.[82] Hence, it is only fair and equitable that all who are involved in space development—either directly by way of utilization or indirectly by way of deriving benefits therefrom cooperate internationally in an effort to find an appropriate mechanism for the conduct of ADR.[83]

In addition, under current circumstances, cleaning up the useful Earth orbits is a technologically challenging and costly activity.[84] In a setting where there are numerous competing priorities in a constrained fiscal environment,[85] the probability that states could pay such a high one-time fee is low, and some states might refuse.[86] Moreover, if the funds are to be collected from spacefaring nations, on what basis

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[79] Agatha Akers. *"To Infinity and beyond: Orbital Space Debris and How to Clean It Up."* U. La Verne L. Rev. 33 (2011): 286.

[80] *Id*. at 312.

[81] Report on ADR and OOS, *supra* note 9, at 39.

[82] *Id*.

[83] *Id*.

[84] *Id*.

[85] *Id.* at 38.

[86] Akers, *supra* note 81, at 313.

should their shares be apportioned? The most impartial formula seems to be in direct proportion to the mass of space debris created by them. Then the next question is whether the space debris that will decay naturally in the future shall be taken into consideration? If so, how is the term "self-decay" to be defined? It should be noted that most of the near-Earth space debris will decay naturally, which is a matter of the lifetime of space debris. Again, it should also be recalled that there is numerous debris that is untraceable, and thus it is difficult to figure out the exact proportion of space debris each state has created.

Next, how should the access fee be calculated? Agatha Akers proposes a starting space access fee of $5 million per unmanned object launched and a $1 million fee per manned launch.[87] The space access fee should be lower for manned launches because these types of excursions into space are less likely than satellite launches to produce orbital space debris.[88] The number of launches may not be the best criterion for the calculation of a space access fee. Instead, the criterion shall be the mass of objects launched including that of the launching vehicles if such vehicles cannot conduct adequate post-mission disposal, and the altitude at which the space objects will remain. The mass is taken into consideration because larger objects are more likely to cause serious damage and disintegrate into numerous pieces than smaller objects. The altitude is relevant because the higher the altitude is, the longer the object will remain in orbit.[89]

Meanwhile, a $1 million fee per manned launch seems to be too high for a fledgling space tourism industry. Although in 2013 Virgin Galactic announced that it was increasing the ticket price from $200,000 to $250,000,[90] most concepts for space tourism developed today envisage a maximum of 4–6 seats for 'tourists'.[91] Hence, a $1 million fee per manned launch is too costly for suborbital flight. A more practical option would be to calculate the access fee on the basis of a certain proportion of the ticket price per passenger, e.g., 10–20%. Such an arrangement could protect the infant industry at its beginnings, and collect more funds when larger suborbital flight vehicles are developed. Moreover, the space access fee for suborbital flight shall be lower than that for the orbital flight. Suborbital spaceflight, which is what most current projects offer, covers flights in which orbital velocities are not achieved, and therefore they usually attain an altitude of around 100 km.[92] Hence, the possibility for a suborbital flight to create space debris is small. Even if some debris is created, it will re-enter into the atmosphere rapidly.

It is advised in this note that the space access fee to be paid by a state shall be proportional to its degree of adherence to the space debris mitigation guidelines and

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[87] *Id*. at 315.

[88] *Id*. at 316.

[89] Report on ADR and OOS, *supra* note 9, at 18.

[90] Jeff Foust. *"XCOR To Raise Ticket Prices for Suborbital Flights."* (2015) *See* http://spacenews.com/xcor-to-raise-ticket-prices-for-suborbital-flights.

[91] Tanja Masson-Zwaan and Steven Freeland, *"Between heaven and earth: The legal challenges of human space travel."* Acta Astronáutica 66.11(2015): 1599.

[92] *Id*.

potential space debris remediation guidelines. One of the drawbacks of these guidelines is that they are not legally binding. Hence, one can only expect other states to behave nicely without anticipating to what extent these guidelines will be adhered to. If the space access fee to be charged depends on the degree of adherence to these guidelines (e.g., full compliance—80% fee, basic but not full compliance—100% fee, and non-compliance—120% fee), a bridge between debris mitigation and debris remediation can be built, and this mechanism will stimulate states to abide by the above guidelines, as the increase in space access fees means not only a higher cost but a subsequent loss of market advantage and customers.

The primary use of the Orbital Maintenance Fund should be to fund the development of technology necessary to effectuate orbital debris removal.[93] Currently, spacefaring nations such as the U.S. and China and regional organizations such as ESA are developing their own ADR technologies respectively. Technological progress would be greatly accelerated if resources can be pooled and cooperation be promoted. Another use of the Orbital Maintenance Fund would be to subsidize the expenses of states in clearing outer space from the existing space debris created in their previous space activities, whether such clearance is done by procurement on a commercial basis, or by the state itself. The underlying logic for this subsidy is that it is unfair to require spacefaring nations to assume the sole responsibility to remove space debris as the whole international community benefits from the exploration and use of outer space. Moreover, such a mechanism would stimulate states to actively conduct ADR as their expenses could be partly compensated and externalized.

Such a system of rewards and penalties would go a long way towards solving the problem of the tragedy of the commons, as under this system the most sensible option for a contracting party, even from the perspective of its own interest, would be to stick to its ADR commitments and adhere to debris mitigation guidelines rather than to disregard them, so as to obtain a subsidy for its ADR expenses and a reduction in the space access fee.

7.6 Liability Issues

The process of debris remediation is more likely to trigger damage and subsequent liability issues than that of debris mitigation, for debris remediation involves unavoidably the movement of space objects, which increases the risk of collision, and accidents could occur during the rendezvous process between the removal mechanism and the target object. These processes might result in the creation of new debris as well as damage to functioning space objects. By comparison, debris

[93] Akers, *supra* note 81, at 311.

mitigation is much less risky. Only Guideline 6[94] and Guideline 7[95] involve the movement of space objects. For other guidelines, the implementation of debris mitigation, such as the minimization of the potential for breakup as contained in Guideline 2 and Guideline 5, is hardly likely to create new debris or to cause damage.

According to the Liability Convention, a launching state shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the Earth or to aircraft in flight.[96] By contrast, in the event of damage being caused elsewhere than on the surface of the Earth to a space object of a launching state, or to persons or property on board such a space object, by a space object of another launching state, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible.[97]

This fault-based criterion has greatly diminished the effect of the Liability Convention on the problem of space debris, for when damage occurs in outer space, the provisions of the Liability Convention cannot provide a clear answer. In addition, the ambiguity of the term "space object" and its relation to space debris as well as the problem of proof when damage is caused by space debris of which the source remains unknown also constitute obstacles to the application of the Liability Convention. There is a great deal of uncertainty about the meaning of "fault" in the Liability Convention, as the term "fault" is not even defined in the convention and it carries many different possible interpretations.[98] If two objects collide, one a piece of debris and another an active space object, it is not automatically the "fault" of the debris.[99] In reality, it could be the fault of neither party.[100]

Article IV of the Liability Convention is the relevant provision when it comes to removal of space objects.[101] If a removal operation causes damage to a third party, the launching states of both space objects (i.e., the removal mechanism and the target object) that cause damage will be jointly and severally liable under the Liability Convention.[102] Again, the location where the damage occurs determines whether absolute liability or fault liability is to be applied.[103]

For amendment of fault liability as contained in Article III and Article IV of the Liability Convention, the Report on ADR and OOS proposes the following:

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[94] Guideline 6: Limit the long-term presence of spacecraft and launch vehicle orbital stages in the Low Earth Orbit (LEO) region after the end of their mission.

[95] Guideline 7: Limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit (GEO) region after the end of their mission.

[96] Art. II, the Liability Convention.

[97] Art. III, the Liability Convention.

[98] Williams, *supra* note 38, at 1159.

[99] *Id*.

[100] *Id*.

[101] Report on ADR and OOS, *supra* note 9, at 32.

[102] *Id*.

[103] Art. IV, the Liability Convention.

> In removing a satellite, there might be the need to cross orbits on the way up or down. This might increase the risk of the entity conducting the removal operation in terms of liability which, in turn, creates an incentive to leave satellites in their orbits even after they are no longer functional. It may be useful to make the point perhaps in a protocol to the Liability Convention that, if someone does the right thing (e.g., by removing a non-functional object from orbit), then fault could be mitigated in some way. In other words, active debris removal and on-orbit satellite servicing will likely occur if the global spacefaring community could come to an agreement not to apply the fault standard to such operations.[104]

However, although a relaxation of the fault standard might relieve the concern of states about legal risks in ADR implementation, a situation shall be avoided where states act less prudently due to such relaxation. Hence, the challenge is to clarify how fault is to be determined. A clear standard, e.g., a code of conduct for the implementation of ADR needs to be established as a criterion to determine whether the state conducting ADR is acting with due diligence. If so, neither the state conducting ADR nor the launching state of the space debris should be held liable. In addition, the guidelines for debris mitigation and debris remediation may also be referred to as a supplementary standard to determine "fault". When fault is determined in accordance with these guidelines, states would better adhere to such guidelines in order to minimize their legal risks.

7.7 Conclusion

As noted by Benjamin Jacobs, all spacefaring states have likely contributed on some scale to the space debris problem, and every state's space debris threatens the entire space ecosystem.[105] The international nature of the space debris problem demands an international solution.[106] There are generally two methods to resolve the problem of space debris, namely debris mitigation and debris remediation. For debris mitigation, international soft laws are already in place which include international guidelines and codes of conduct, the most notable and pertinent of which are the IADC Guidelines and the COPUOS Guidelines. However, in addition to their non-legally binding nature, these guidelines, as their names indicate, only address debris mitigation but not debris remediation. At the current stage, studies on debris remediation are mostly theoretical.

It should be noted that debris mitigation alone is not sufficient. According to all available findings at international level, the Kessler syndrome, the increase in the number of space debris in Low Earth Orbits due to mutual collisions, appears now to be a fact, and the time may have come to study how to clean this fundamentally

[104] Report on ADR and OOS, *supra* note 9, at 32.

[105] Benjamin Jacobs. *"Debris Mitigation Certification and the Commercial Space Industry: A New Weapon in the Fight against Space Pollution."* Media L. & Pol'y 20 (2011): 117.

[106] *Id*.

useful orbital region in an active way.[107] While the international soft laws would be a way to solve the problem of debris mitigation, an international agreement is needed for debris remediation, for the latter poses many legal challenges that can only be dealt with through legally-binding rules. A fundamental question is what should be removed, namely, the definition of space debris. The function-based criterion to distinguish space debris from active space objects is advocated in this note, for the control-based criterion is incompatible with non-maneuverable but functional satellites such as CubeSats. Another question is the correlation between the terms "space debris" and "space object". The latter term is widely used but not clearly defined in the UN space treaties. It is advised in this note that "space debris" shall be defined as a constituent category of the term "space object" so that provisions of the UN space treaties regulating "space objects" can apply to space debris. Meanwhile, specific rules should be made taking into account the special characteristics of space debris, e.g., non-functional, mostly non-controllable, and necessary to be removed. Where there are discrepancies between the specific rules on space debris and the general rules as contained in the UN space treaties, the former shall prevail in accordance with the *lex specialis derogat legi generali* doctrine.

After defining space debris, the next question is in what order shall space debris be removed, i.e., what kind of space debris should be given a priority of removal? It is generally agreed that five large objects must be actively de-orbited from densely populated orbital regions in order to keep the orbital environment stable.[108] Large debris is mostly tracked by the United States Space Surveillance Network (SSN) and cataloged, meaning that this debris can be attributed to a particular state. According to the Outer Space Treaty, the state of registry shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body.[109] Such jurisdiction and control over space objects constitute an obstacle for the implementation of ADR, as prior consent is required for the removal of space objects carried on the registry of another state. Due to strategic considerations and national export restrictions, such obstacles are difficult to overcome. At the current stage, the most feasible solution would be the subscription of governments to concurrently sign an agreement to remove on a periodic basis a certain percentage of space debris created by their own national space activities.[110]

After answering the above questions, the following question is how these activities should be funded. ADR technologies are not yet mature, and further scientific and technological endeavors are required. To avoid reinventing the wheel, resources should be pooled to promote technological development to ensure the cost-effectiveness and safety of the implementation of ADR. To this end, an Orbital Maintenance Fund should be established. A space access fee should be charged per

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[107] Christophe Bonnal, J. M. Ruault, and M. C. Desjean, *"Active debris removal: Recent progress and current trends."* Acta Astronautica 85 (2013): 51.

[108] *Id*. at 53.

[109] Art. VIII, the Outer Space Treaty.

[110] Report on ADR and OOS, *supra* note 9, at 40.

launch depending on the mass of objects launched into outer space. The fee rate should be differentiated between unmanned space mission and human spaceflight, as well as between orbital flight and suborbital flight. The access fee should be varied according to the compliance of states with the guidelines on space debris. The two major uses of the Orbital Maintenance Fund would be to promote technological development and to subsidize the expenses of states for the removal of their existing space debris. Also, the potential liability issues in the process of ADR need to be addressed. A clear definition of "fault" should be provided and a code of conduct for ADR should be established as a criterion for the determination of fault.

In fact, in addition to the elements that have been discussed above, there are other issues that also require consideration for the establishment of an international regime on ADR, including the enforcement of the transparency and confidence-building measures, the establishment of an international organization for the supervision and administration of debris remediation, etc.

In brief, the clearance of space debris is an intricate challenge for the whole international community involving considerations from technical, legal, economic, political and military perspectives, in which the interests of different states need to be carefully balanced. Continuous efforts should be made to confront these challenges and to maintain the sustainability of outer space for the needs and interests of future generations.

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Chapter 8
Active Debris Removal, International Environmental Law, and the Collective Management of Risk: Foundations of an International System for Space Traffic Management

Ward Munters

Abstract The analysis in the current chapter advances the discussion on the interrelationship between space debris, active debris removal and space traffic management, and on how they must necessarily be conceptualised and implemented should the international community prefer to safeguard the sustainability of mankind's space activities. The first section juxtaposes the state of a number of regulatory developments on the above issues with a cursory look at the inescapable physical circumstances and processes surrounding space activities and space debris, in order to derive a number of fundamental implications for the creation of an effective future regulatory system. What emerges, above all, is the need for suitably tailored, adaptive and largely unprecedented international legal 'machinery' based on a common construction of the risk attending space activities. *De lege lata* and *de lege ferenda*, the chapter then briefly situates and qualifies the issues under general international law and the jurisprudence of the International Court of Justice (ICJ) in the context of international obligations to prevent transboundary harm—an area of international environmental law notably concerned with risk and its collective management—before finally concluding.

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8.1 Introduction

"Legal imagination is needed to develop law to respond to a world of multiple interconnected parties, scientific uncertainty, and socio-political conflict", argues Fisher when recently demonstrating how the dynamic character of environmental law and the diverse matters it seeks to regulate "force imaginative reflection on the part of environmental lawyers" and policymakers.[1] Interestingly, nearly six decades earlier, Jessup and Taubenfeld rather more negatively noted that "[s]ome of the current spate of writing about outer space is so highly imaginative as to discourage serious students of international organization and law from pursuing detailed studies of very real problems which now confront the UN."[2]

For the large part, international environmental law and international space law as discrete areas of international law substantially developed only after[3] Jessup and Taubenfeld's observation. Today, however, legal scholars can scarcely ignore the importance of environmental regulation of human activity and so, too, 'serious students' of space law have increasingly turned to environmental law for answers that at a glance would appear absent from the *corpus iuris spatialis*.

Indeed, on the basis of the foregoing, we might conclude that international space law and international environmental law are both entwined around a common strand of the imaginative. If outer space and its regulation have long captured our imagination, whether for good or for bad, then what better subject to propel us towards much needed 'imaginative reflection'? There is thus good reason to assume that in their mutual relationships we might well find cogent notions that can instil within us precisely that imagination so necessary to contend with global environmental problems.

For our current purposes, one such environmental problem is that of space debris and the methods with which to comprehensively attend to it. Space debris has gained unparalleled prominence on scientific, technical, legal and political agendas in connection with the future sustainability of mankind's activities in outer space. Hence, we turn our attention in this chapter to space debris in general, and active debris removal (ADR) in particular, for the latter is not only a space activity but is also intrinsically connected to solving the problem of space debris. In so doing, international environmental law may teach us something concerning the manner in which to organise and regulate mankind's activities in outer space—albeit circumterrestrial space[4]—while the purported "fabulous"[5] nature of these activities may, in

[1] E. Fisher, *Environmental Law: A Very Short Introduction*, Oxford, Oxford University Press, 2017, 51.

[2] P.C. Jessup and H.J. Taubenfeld, "Outer Space, Antarctica, and the United Nations", *International Organization* 1959, Vol. 13, No.3, 363.

[3] Doctrinal debate on whether "there existed a corpus of international rules that might be described as 'International Environmental Law'" continued up until the early 21st century, on which see the discussion between Sands and Brownlie, as referenced in P. Sands, "Climate Change and the Rule of Law: Adjudicating the Future in International Law", *Journal of Environmental Law* 2016, 26, note 30.

[4] The analysis in this chapter mostly concerns the near-Earth orbits and the accumulation of space debris in that circum-terrestrial region of outer space. The conclusions with regard to circum-terrestrial space debris might not necessarily be applicable to other areas of outer space or to activities on or around other celestial bodies.

[5] P.C. Jessup and H.J. Taubenfeld, *supra* note *3*, 363.

turn, enable us to imagine a collective way forward with regard to international environmental law itself.

In what follows, I mean to distil from such juxtaposition a number of fundamental inferences concerning the construction of a future general framework for international space governance[6] in light of the sustainability of mankind's space activities. Tentatively, I posit the view that irrespective of the precise form, nature or substance of any international space governance regime yet to be constructed, such a regime will need to be predicated upon at least one determinative pillar: *risk and the collective management thereof*. In this view, it would thus appear indispensable for the international community to arrive at a common construction of *the risk attending space activities*.

To that end, I first explore three distinct ways in which 'legal imagination' with regard to international space and environmental law may take form and what we might learn therefrom. In the subsequent section, I briefly situate space debris and active debris removal in the context of obligations to prevent transboundary harm—an area of international environmental law notably concerned with risk and its collective management—before finally concluding with a view as to the future.

8.2 Three Layers of Legal *Imagination*

An appeal to 'imagination' is rather indeterminate from the outset. The concept can denote a great many things to equally as many interpreters. We will therefore adopt for our purposes three subtly distinct but mutually delineated definitions of the term,[7] as follows.

8.2.1 A Vivid Imagination

For one, imagination is said to be 'the ability to form pictures in the mind'. First, let us picture here the image of a game of golf being played on the Moon.[8] As is well known, the Moon is considerably less massive than is the Earth, such that

[6] Proposals for a comprehensive system for 'Space Traffic Management' (STM) are especially notable in this regard. We can expect an updated version by the International Academy of Astronautics (IAA) of their original 2006 Cosmic Study on STM. On the former see the website of the IAA, available at https://iaaweb.org/content/view/615/809/ ('Space Traffic Management – Towards a Roadmap for Implementation'), last accessed on 4 April 2018. On the latter see C. Constant-Jorgenson, P. Lala and K.-U. Schrogl (Eds.), *Cosmic Study on Space Traffic Management*, Paris, The International Academy of Astronautics (IAA), 2006, 96p.; C. Constant-Jorgenson, P. Lala and K.-U. Schrogl, "The IAA Cosmic Study on space traffic management", *Space Policy* 2006, 283–288.

[7] The definitions of 'imagination' in the online *Cambridge English Dictionary* are used, available at http://dictionary.cambridge.org, last accessed on 4 April 2018.

[8] This particular game of golf need not remain relegated to our imagination; the film of Alan Shepard's famous golf swing on the Moon during the Apollo 14 mission is readily available on the Internet.

> the earth exerts a stronger pull on an object placed on its surface than that which the object experiences on the surface of the moon, which explains why the astronauts get to bounce so high when they are on the moon, and how Alan Shepard managed to set a galactic record in 1971 for driving a golf ball – by his account 'miles and miles' – with a six-iron attached to a sampling rod.[9]

We might then ask ourselves a deceptively simple question: would it be logical, or even fair, to impose the same rules on a game of Lunar golf as are applied on Earth, or *vice versa*?

Intuitively and emphatically, the answer is 'no'. Firstly, it would not be logical, for the absence of an atmosphere on the Moon in combination with its diminished gravitational pull changes the very nature of the game. The 'physical realities'[10] as well as the factual circumstances surrounding activities in the Lunar environment—or, *mutatis mutandis*, in outer space—differ so radically from those of everyday life on Earth as to compel us to at least consider introducing a set of rules more specifically tailored to this new environment.[11] Secondly, neither would it be fair; or equitable,[12] in a more legally precise sense. From the opposite perspective, for example, the most prodigiously talented golf players on Earth could never hope to surpass Shepard's 'galactic record', and we would be justified in expecting them to voice their disagreement in protest to being held to the same standards under wholly different circumstances.

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[9] L. Tribe, "The Curvature of Constitutional Space: What Lawyers Can Learn from Modern Physics", *Harvard Law Review* 1989, Vol. 103, No. 1, 3.

[10] A. Soucek, "Perspectives on Future Space Traffic Management", presentation for the 10th UN Space Law Workshop, 5 September 2016, Vienna, Austria, available at http://www.unoosa.org/pdf/SLW2016/Panel1/3._Soucek_Future_perspectives_of_space_traffic_management_Soucek_final.pdf, last accessed on 4 April 2018.

[11] The general idea that the law should be based on the relevant facts is expressed by the adage 'ex facto sequitur lex', on which in regard to space activities see, e.g., E. Vitt, "Space debris: Physical and legal considerations", *Space Policy* 1989, 129–137; L. Perek, "Planetary protection: lessons learned", *Advances in Space Research* 2004, Vol. 34, 2369.

[12] Equity concerns in connection with current and future international regulation of space activities, as well as the mitigation and remediation of space debris, also appear as highly relevant in the context of the application to space activities of the principle of 'common but differentiated responsibilities' (CBDRs), on which see P. De Man and W. Munters, "Reciprocal Limits to the Freedom to Use Outer Space by All States: Common but Differentiated Responsibilities?", *Air & Space Law* 2018, Vol. 43, 21–51. For example, we might reasonably anticipate the principle continuing to infuse discussions on the equitable allocation between (spacefaring) nations of responsibilities concerning space debris and, thus, the common management of risks attending space activities that arguably resides at the heart of the issue. There is obvious potential for divisiveness regarding the perceived equity in the apportionment of responsibilities—e.g., differentiated thresholds of risk that can be actively undertaken, must be passively tolerated, or shall be actively mitigated—in the light of increasingly entrenched positions taken by states, relative to historical contributions and current capabilities with regard to space debris and its management. This may impede the crystallisation of a more common construction of risk: One that takes into proper account the absolute threshold, indiscriminately looming, above which the utility of valuable orbital bands is significantly impaired for any entity, and which is entirely indifferent to the origin of, or responsibility for, space debris.

Therefore, a first lesson to be drawn from legal imagination is that we must take care not to simply transplant *outright* the whole, or even facets, of international environmental law, with its decidedly terrestrial origins, to activities in outer space, on the Moon or on celestial bodies.[13] That is not to say that environmental law or its precepts are inappropriate or inapplicable with regard to outer space *ab initio*. On the contrary, we bear the onus to carefully consider when and how environmental rules apply or are to be crafted, precisely to ensure that Article III of the Outer Space Treaty (OST) receives due consideration. Concerning such application solely beyond Earth, we will need to take similar account, for example, of the variable spatiotemporal exigencies at different times, at various altitudes or between different orbital eccentricities[14]—to say nothing of the unique environments of disparate areas of outer space or the multitude of celestial bodies. Of course, neither do these factual circumstances remain immutable in the face of expanding human activity. Regulations will have to adaptively accommodate environmental variations of an anthropogenic nature as well.

In sum, it is probable that any system intended to *effectively* and *equitably* govern the conduct of entities in space will require adaptive mechanisms that allow for the imposition and enforcement of finely tuned, interconnected and appropriately readjusted regulation according to the variable environmental exigencies that circumscribe any particular space activity or permeate any particular area of outer space.

8.2.2 An Imagination at Odds with Reality

Secondly, imagination can signify 'something that you think exists or is true, although in fact it is not real or true'. Here, let us enumerate a number of things the existence or 'truth' of which is corroborated by a growing corpus of technical and scientific literature on space activities and space debris, in order to determine what exactly constitutes legal imagination with this more negative connotation.

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[13] We might express this in the well-known adage of 'mutatis mutandis'.

[14] As an example, consider that "[t]he extra energy dumped into the Earth's upper atmosphere during solar maximum causes the Earth's atmosphere to bloom outward as compared with solar minimum. This effect increases the density in LEO by a factor of 1–3 orders of magnitude, depending on altitude, and about a factor of 3 compared with the long-time average. As a result, atmospheric drag deorbit devices are much more efficient during solar maximum, pose a lower risk to operating satellites, and have a lower chance of creating new, large debris objects. Permitting a satellite to use a smaller drag device over 25 years, which will average about two solar cycles, means it will incur about three times the risk compared with a larger device selectively operated near solar maximum (including the time taken waiting for solar maximum). As a result, it is recommended that drag-augmentation devices be sized and timed to complete their deorbit function only during solar maximum to further reduce the risk of creating new debris." K.T. Nock, K.M. Aaron and D. McKnight, "Removing Orbital Debris with Less Risk", *Journal of Spacecraft and Rockets* 2013, Vol. 50, No. 2, 379. For another analysis of how variations in these parameters can lead to considerably dissimilar effects on, and from, space activities, see J. Radtke, C. Kebschull and E. Stoll, "Interactions of the space debris environment with mega constellations – Using the example of the OneWeb constellation", *Acta Astronautica* 2017, Vol 131, 55–68.

To begin, if we define 'risk' for our current purposes in simplified terms of *probability times consequence* (probability × consequence),[15] then the total risk posed by a space object[16] or a space activity—be it either directly through collision or indirectly through potential creation of debris—to other space objects or space activities, is naturally amplified as space actors, space activities, and space objects grow more numerous. The result is the evident intensification of the 'risk' attending any space activity, expressed by the growing probability of a space activity or space object affecting another space activity or space object, and multiplied by the concomitant expansion of potential consequences arising from the space activity on the latter ever-growing group—for example, through collisions between space objects or further collisions with resultant debris. That is to say, more actors, objects and activities lead to augmentation of both the probability and thus frequency of them affecting each other, as well as of the enormity of any consequences arising therefrom. Given enough time and some arbitrary degree of unregulated growth, the risk so expressed would ostensibly tend towards absolute certainty.[17]

If that notion of risk seems rather abstract it is perhaps necessarily so, for there exists no sufficiently harmonised international conception of what *precisely* constitutes risk attending space activities, let alone of the sustainable threshold or management of further activity to be inferred therefrom. Even so, establishing a more abstract normative notion of risk may enable us to meaningfully capture some of the more elusive factors that cannot be *a priori* derived from scientific calculation and that therefore remain fundamentally uncertain,[18] or that go beyond what can be practically established through case-by-case impact assessments concerning a singular space activity.

For example, we can only estimate the *precise* threshold above which the accumulation of space debris in regions of circum-terrestrial space will trigger a runaway collisional cascade effect that will render those regions largely inhospitable to

[15] D. McKnight, "Massive Collision Monitoring Activity (MCMA): Examining Urgency and Options for Debris Remediation", Presentation for UN COPUOS, 8 June 2017, Vienna, Austria, available at http://www.unoosa.org/documents/pdf/copuos/2017/copuos2017tech04E.pdf, last accessed on 4 April 2018.

[16] Space objects in the broadest possible sense, comprising 'space debris' as well as operational spacecraft.

[17] For example, "[w]hile the probability of accidental collision with a 'live' space object is yet statistically small, it does exist, and a continuation of present practices insures that this probability will increase to unacceptable levels". Excerpt from the UNISPACE 82 report, as quoted in W.B. Wirin, "Space Debris 1989", *Proc. On L. Outer Space* 1989, Vol. 32, 184.

[18] Apart from scientific uncertainty related to the limited resolution of current debris models, *inter alia*, more generally we might also bear in mind that "[t]o search the sciences for authoritative answers to legal questions, or any questions for that matter, is misguided. The formalist philosophy which views science as a 'collection' of the 'proven' or even of the 'provable' is based upon an inappropriate reification. The better vision of science is as a continual and, above all, critical exploration of fruitful insights; the better metaphor is that of a journey. Science is not so much about proving as it is about improving. To look to the natural sciences for authority—that is, for certainty—is to look for what is not there." L. Tribe, *supra* note 10, 2.

further human activity—i.e. the Kessler Syndrome.[19] Nevertheless, we can reasonably postulate in a more abstract sense that the prevention of that scenario, and thus the mitigation of the aggregate 'risk' of its occurrence, is a universally acceptable end to be absolutely achieved, for the alternative would be unjustifiable by any stretch of the imagination. Although scope precludes an exhaustive examination of *how to manage the risk* attending space activities against that looming horizon,[20] at the very least we can explore *the manner in which we should definitely not*.

In connection with the chain of *consequence* arising from a space activity, for example when a space object disintegrates following a collision with another space object, the distribution of generated debris fragments changes over several months so as to

> […] evolve into a uniformly distributed band. Such a distribution state of the debris cloud is the so called "chaotic motion" of debris cloud [sic], which means that the debris has lost reference to its specific initial conditions.[21]

The legal implications of this physical process should be clear to 'serious students' of international space and environmental law. Firstly, traditional legal notions of liability are largely rendered irrelevant with regard to such fragmentary and irremediable debris,[22] if only because the loss of reference to specific initial conditions would ostensibly prevent a claimant from adducing the evidence necessary to establish causation or to identify the responsible actor, *a fortiori* in the absence of any capability to continuously track the fragments from the moment of their creation. This holds true even for proposed regimes of strict liability for space activities. Secondly, the group of entities potentially affected by the disintegration of a space object is not limited to those entities who at the relevant time are immediately sub-, super- or adjacent to the fragmentation event,[23] but encompasses all entities residing

[19] For example, Klinkrad estimates "that cascading debris generation, otherwise referred to as the Kessler Syndrome, will begin within the next 20 years unless action is taken to reduce the existing population." As noted in P.A. Slann, "Space debris and the need for space traffic control", *Space Policy* 2014, 41.

[20] The institution of a global system for STM would appear especially apt in this regard, see *supra* note 7.

[21] For the quoted text and further references related to 'chaotic motion' in the distribution of debris fragments, see B. Zhang, Z. Wang and Y. Zhang, "An analytic method of space debris cloud evolution and its collision evaluation for constellation satellites", *Advances in Space Research* 2016, Vol. 58, 907–909.

[22] For a more complete overview of the fundamental deficiency of a liability or reparation regime for damage caused by, or harm arising from, space debris in connection with the sustainability of space activities and the protection of the space environment, see W. Munters, "Small satellites, large constellations and space debris: *in dubio pro LEO*?", in J. Wouters, P. De Man and R. Hansen (Eds.), *Commercial Uses of Space and Space Tourism: Legal and Policy Aspects,* Cheltenham, Edward Elgar Publishing, 2017, 75–110.

[23] In the same vein, consider: "If a collision were to occur in heavily populated orbital regimes, such as the sun-synchronous orbits or GEO, this would have even greater effect. A collision in GEO will distribute debris throughout the entire belt within a day. […] A collision in the commercially popular sun-synchronous orbits could result in costly direct costs to locally operating satellites, and make future operation in such sun-synchronous orbits more challenging. Both of these narrow orbit regimes are special in that the operators are flying there to take advantage of particularly favourable

within or traversing the affected orbital bands.[24] Thus, the consequences of a calamitous event in circum-terrestrial space[25] are far from limited to a particular location or to a narrowly predefined group of entities and, proportional to the altitude, might last for a very long time.

As pertains to the *probability* of the occurrence of an event negatively impacting the safety and sustainability of space activities in the above manner, let us briefly examine the recent Memorandum Opinion, Order and Authorization by the United States Federal Communications Commission (FCC) regarding a proposed constellation of 4425 non-geostationary orbit (NGSO) satellites.[26] Of particular note are the comments filed by the National Aeronautics and Space Administration (NASA) to the FCC, stating that

> (1) the reliability of the design and fabrication of the spacecraft and the reliability that the spacecraft can accomplish the post-mission disposal are of particular interest from the perspective of keeping the orbital environment safe, and that currently, no consensus exists on what the two reliability numbers should be, and (2) a design and fabrication reliability on the order of 0.999 or better per spacecraft may be prudent to mitigate the risk of malfunction in a 4,000+ spacecraft constellation.[27]

On the one hand, the absence of consensus on prerequisite reliability underscores precisely the absence of a harmonised construction of risk attending space activities, be it at the domestic or international level. On the other, while the admittedly provisional reliability factor of 0.999 essentially amounts to a recommendation of near-perfect reliability for the spacecraft and its functions,[28] there remain inescapable exogenous factors of a nature to influence that reliability, and of which proper

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orbital physics. These mission types are not possible by simply moving the GEO satellite to a lower orbit, or changing the plane of the sun-synchronous spacecraft." H. Schaub, L.E.Z. Jasper, P.V. Anderson and D.S. McKnight, "Cost and risk assessment for spacecraft operation decisions caused by the space debris environment", *Acta Astronautica* 2015, Vol. 113, 73.

[24] If we expand the scope of his argument to encompass the near-Earth environment, Brownlie was undoubtedly correct when noting of activities in space that "[s]ome activities may cause, or create the risk of, harmful and perhaps irreversible changes in the earth's environment. The threat here is not *in personam* but to mankind and the community of States as a whole." (emphasis in original). I. Brownlie, "The Maintenance of International Peace and Security in Outer Space", *British Yearbook of International Law* 1964, Vol. 40, 30.

[25] Precisely in this area does the traditional language of international law falter, largely based, as it still is, on concepts of territorial sovereignty that present difficulty when attempting to construe these into 'machinery' to regulate novel problems of a mostly extra-territorial nature.

[26] FCC, Memorandum Opinion, Order and Authorization concerning *Application For Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System*, FCC 18–38, adopted on 28 March 2018, released on 29 March 2018, available at https://transition.fcc.gov/Daily_Releases/Daily_Business/2018/db0329/FCC-18-38A1.pdf, last accessed on 10 April 2018.

[27] *Ibid.*, 8, note 54 ('NASA Comments').

[28] The need for a dramatic increase in reliability of deorbiting and control systems for constellation spacecraft has also been noted by the Inter-Agency Debris Coordination Committee (IADC), on which see IADC, *Statement on Large Constellations of Satellites in Low Earth Orbit*, IADC-15-03, September 2017, available at https://www.iadc-online.org, last accessed on 10 April 2018. For a more detailed legal analysis of these reliability concerns in light of a precautionary approach and the impact on the space environment, see W. Munters, *supra* note 23.

account cannot be taken by sole reference to the operator or the spacecraft of the constellation. Indeed, whereas debate continues in legal doctrine on, for example, *de facto* appropriation of orbits by means of certain space activities in possible contravention of Article II OST, or on the precise substance and scope of the reciprocal rights and obligations emanating from the principles of cooperation and mutual assistance or of due regard in Article IX OST, for the time being we can plausibly foresee at least more than one otherwise unrelated entity legitimately conducting space activities in the vicinity of such a constellation.

Hence, a further lesson is revealed: the 'risk' posed by, and to, a space activity cannot be assessed *in vacuo*—in 'splendid isolation' from the unfolding space activities of other entities. Moreover, insofar as some forms of minute coordination between otherwise unrelated space activities would be required in order to mitigate the aggregate risk to other entities or to the sustainability of mankind's space activities so as to remain below acceptable thresholds, it would appear that neither can the operational management of that risk be undertaken in an insular fashion. It is therefore submitted that the future construction of any space governance regime, be it national or international, that proceeds from the assumption that such management can be effectively undertaken *ad hoc,* in a unilateral manner, or without an enduring cooperative framework under which to coordinate space activities,[29] would amount to 'legal imagination' of the least redeemable kind.

This lesson is not merely an academic abstraction, as is evidenced, for example, by recent legislative developments in connection with commercial space activities in the United States House of Representatives. The American Space Commerce Free Enterprise Act of 2017,[30] though not yet enacted into domestic law at the time of writing, contains disconcerting language and provisional stipulations in connection with the risk posed by space activities. After noting that the primary role to authorise and supervise new private space activities would be assigned under the Act to the Office of the Secretary of Commerce—an office without traditional experience in such matters—Liu and Tronchetti continue, that while

> [i]t is certainly true that safety is still a matter of primary importance, as demonstrated by the requirement to assess the risk that the certified operation poses to space objects operated by the Federal Government. It is, nevertheless notable that such an assessment takes place after the operation has already started (one would assume that such an evaluation would be done prior to the mission) and that the risk is evaluated only in relation to U.S. space objects, regardless of their potential hazardous impact on the long-term sustainability of space activities broadly considered (including those undertaken by foreign entities). It is also notable that the bill never addresses concerns over issues like space situational awareness and traffic management.[31]

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[29] See *supra,* note 7.

[30] Bill, American Space Commerce Free Enterprise Act of 2017, available at https://science.house.gov/sites/republicans.science.house.gov/files/documents/2017%2006%2001%20232%20Free%20Enterprise%20Act%20HR%20Blank.pdf, last accessed on 10 April 2018.

[31] H. Liu and F. Tronchetti, "The American Space Commerce Free Enterprise Act of 2017: The latest step in regulating the space resources utilization industry or something more?", *Space Policy* 2018 [ARTICLE IN PRESS], available at https://doi.org/10.1016/j.spacepol.2018.02.004, last accessed on 10 April 2018.

Further, we may also briefly consider the indications of an altogether meagre rate of international compliance with current mitigation measures as contained in the Space Debris Mitigation Guidelines (SDM Guidelines) of the Committee on the Peaceful Uses of Outer Space (COPUOS) or the Inter-Agency Debris Coordination Committee (IADC).[32] It would appear that the effectiveness of non-binding international guidelines concerning the sustainability of space activities is, in fact, rather *imaginary*.[33] Let us not forget either that the validity and robustness of the SDM Guidelines is being thoroughly questioned by the IADC.[34] In this sense, legal imagination is to contend that such guidelines, including the recent Guidelines on the Long-Term Sustainability of Outer Space Activities (LTSSA Guidelines), while valuable, would amount to anything beyond a preliminary and political consensus-seeking exercise in preparation of a more effective, and effected, collective system for space governance. A system, moreover, we can reasonably assume is to be founded on the legitimate rule of law.[35]

8.2.3 A Creative Imagination

Finally, let us define imagination in its third sense as 'the ability to think of new ideas'. From this, I continue in two ways. First, I establish a general frame of reference for further debate, based on the future role of international environmental law

[32] Notably, recent studies "have shown that disposal operations to meet a 25-year post-mission limit in the LEO protected zone is followed only by approximately 20% of space systems today." B. Bastida Virgili et al., "Risk to space sustainability from large constellations of satellites", *Acta Astronautica* 2016, Vol. 126, 155. See also V. Morand, J.C. Dolado-Perez, T. Philippe and D.A. Handschuh, "Mitigation Rules Compliance in Low Earth Orbit", *Journal of Space Safety Engineering* 2014, Vol. 1, No. 2, 84–92.

[33] The diminutive degree of compliance must of course also be taken as evidence of the reluctance of spacefaring States and operators to implement costly mitigation measures. That reluctance will naturally frustrate attempts to arrive at a legally binding framework despite ongoing deterioration of near-Earth space. For an extensive analysis of the various risks and costs in connection with space debris, its mitigation and its remediation, see H. Schaub et al., *supra* note 24, 66–79.

[34] IADC, *supra* note 29.

[35] In this respect, consider the following non-binding but authoritative paragraphs in the Declaration of the High-level Meeting of the General Assembly on the Rule of Law at the National and International Levels: "We agree that our collective response to the challenges and opportunities arising from the many complex political, social and economic transformations before us must be guided by the rule of law, as it is the foundation of friendly and equitable relations between States and the basis on which just and fair societies are built", as further strengthened by the recognition "that the rule of law applies to all States equally, and to international organizations, including the United Nations and its principal organs, and that respect for and promotion of the rule of law and justice should guide all of their activities and accord predictability and legitimacy to their actions. We also recognize that all persons, institutions and entities, public and private, including the State itself, are accountable to just, fair and equitable laws and are entitled without any discrimination to equal protection of the law." Resolution 67/1 of the United Nations General Assembly (30 November 2012), *UN Doc*. A/RES/67/1 (2012), 1.

and the rule of law in global society. Secondly, I look at the state of the rule of law in the context of mankind's activities in outer space.

8.2.3.1 Environmental Law: A Proper Frame of Reference

Fisher is correct in her contention that legal imagination is required to confront the environmental problems of today[36] and it can be said with some confidence that international environmental law concerning (the prevention of) transboundary harm in particular has a seminal role to play on the world stage. This is hardly surprising. One of the effects of the gradual erosion of the traditional boundaries dividing states, in favour of a more interconnected and interdependent international community, has been to force our collective awareness to encompass the inescapable fact that consequences, arising from certain activities, permeate the geographical boundaries otherwise neatly dividing the Earth into parcels of sovereign territory. We may use particular terminology—for example, 'transnational' or 'extra-territorial'—to denote that these issues transcend "the classical structure"[37] of the international legal order. But we must also recognise that the legal language of which international lawyers, institutions and states avail themselves has lagged behind the very real and very pressing factual developments confronting global society—for example, climate change or the proliferation of space debris.

Arguably, the deliberate and precise nature of the law—esteemed qualities as well of the scholars that study it and the lawyers that practice it—is such as to require adherence to fundamental principles of predictability, equity and legitimacy, among others. This makes the law into a powerful construct that is, however, slow to evolve. Be that as it may, the uncomfortable and often understated truth of the matter is that the global problems now facing mankind, in any number of domains, are absolutely unprecedented in their scope and urgency as well as in their ability to impede mankind's future progress. To call upon the rule of law to form part of the solution under these conditions—and I take for granted that we must—is therefore to require nothing less of the rule of law than to profoundly transform itself in an equally unprecedented manner. In short, we will simply have to *imagine* a way forward.

8.2.3.2 A Creative Imagination: Towards International Space Traffic Management?

Under our third definition of imagination, international initiatives aiming to institute a global system for space traffic management (STM),[38] rooted in public international law, emerge as highly *imaginative*, for they precisely seek to provide novel

[36] E. Fisher, *supra* note 2.

[37] P. Sands, *supra* note 4, 22.

[38] See *supra*, note 7.

'machinery' for the control and regulation of potentially harmful activities in outer space. All the more, given that "the language in which we still tend to ask legal questions and express legal doctrine has yet to reflect the shift in our perceptions",[39] and that the institution of such a system would beneficially correspond with our above determination of the tenuous connection between present tendencies in international space governance and the modern realities surrounding space activities. Let us explore that tenuous connection a little further.

Ever since its codification into a conventional norm in 1967, Article III OST stipulates in certain terms that States Parties shall carry on space activities in accordance with international law. The preceding general endorsement of that precept by the community of states[40] motivated Brownlie to posit in 1964 that "[it] follows from this position that there is no legal vacuum waiting to be filled with a composite body of rules having a special nature, a new legal entity, 'space law'."[41] In retrospect, however, we must perhaps recognise that international law in general, and international environmental law in particular, have only marginally succeeded in piercing the normative veil that has long appeared to imperceptibly separate activities in outer space as somehow distinct from those on Earth.

Without examining the matter here in detail, it is plausible that this circumstance can more generally be attributed to the ostensibly feeble position held by the international rule of law in regard to activities carried on in outer space by states or by the actors under their supervision. Indeed, rare must be those areas of international law wherein commentators can cite literature from the middle of the previous century as if it were contemporary legal doctrine—intentional references in the current chapter included—or in whose *acquis* not a single noteworthy pronouncement from an international judicial body can be found. As to the underlying reasons, we might look to the provisions in the space treaties, often purported to be of lacunal character and therefore to offer ample scope for divergent conduct. Even so, the general nature of the provisions precisely extends so far as to cover "all activities by public and private entities that can be characterised as exploration or use. The lack of detailed rules regulating every conceivable activity in space should thus not be taken as an indication that there are forms of exploration or use of outer space that escape the application of the fundamental principles of international space law."[42] Above all, however, it is the politically and strategically expedient reticence by spacefaring states to submit themselves to detailed international rules that appears most likely to perpetuate the veil.

Yet, as we have seen, there are pressing reasons, empirical or otherwise, to insist that "the conduct of States in regard to outer space must be submitted to the

[39] L. Tribe, *supra* note 10, 2.

[40] See, for example, Resolution 1721 (XVI) of 1961 and Resolution 1962 (XVIII) of 1963 of the United Nations General Assembly.

[41] I. Brownlie, *supra* note 25, 2.

[42] P. De Man, "State practice, domestic legislation and the interpretation of fundamental principles of international space law", *Space Policy* 2017, 92.

rule of law",[43] properly established, and thus to forcefully insist on reviving what appears to be the dead letter of Article III OST. Similar reasons apply to the need to renew efforts towards the appropriate application of international environmental law to mankind's activities in outer space.[44] To that end, I propose to fully subscribe to the incisive analysis by Brownlie, as relevant today for our environmental purposes as they were for his own reasons more than half a century ago, namely that:

> [I]n working on the assumption that rules already exist which apply to activities in space it will be borne in mind that the precise manner of their application will not infrequently remain the subject of debate and that in some spheres one is dealing quite simply with the progressive development of the law and not merely the refinement of existing rules. The line between *lex lata* and *lex ferenda* is often difficult to draw […] the optimum conditions for peace and security in this field, as in others, are created by political understanding and more especially by the conclusion of agreements […] providing machinery for the control of harmful activities. The general law normally should contribute to the solution of these large issues by providing the technical framework for particular arrangements. However, in conditions of political distrust, it is as well to point out that the paucity of special agreements does not leave States to shape their policies in complete freedom.[45]

Following this line of argument, it will be fruitful to cast a glance at space debris and active debris removal in the light of international environmental law—not only for the lessons it may hold for the common construction of risk attending space activities, and thus for an effective and equitable space traffic management regime but, crucially, to accentuate that "[l]egality does not wait upon perfection",[46] nor do spacefaring states enjoy boundless freedom in anticipation of a more expansive *sui generis* space governance regime.

To be sure, much of the 'current spate of writing' and international adjudication on transnational and extra-territorial environmental problems appears, however slowly or incrementally, to be developing along a normative axis pointing towards intensified international cooperation and coordination. If we concede to the likelihood that due to the unique physical realities in circum-terrestrial space and the immediate, indiscriminate consequences of space activities on any entity active therein, the international community will be compelled sooner, rather than later, to arrive at a novel framework for effective international space governance, then we might hope that valuable lessons might be drawn therefrom for creating 'legal machinery' to collectively overcome the many other global challenges closer to home. From this perspective, it might be equally fruitful somewhere in the near future for serious students of international law and organization to study interna-

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[43] M. Lachs, *The Law of Outer Space: An Experience in Contemporary Law-Making,* Leiden, Sijthoff, 1972, 6–7.

[44] In this respect, note that "environmental space law is simply a specialized area of environmental law". F. Lyall and P.B. Larsen, *Space Law: A Treatise*, Surrey, Ashgate Publishing Company, 2009, 275.

[45] I. Brownlie, *supra* note 25, 2–3.

[46] *Ibid.*, 2.

tional law in light of space debris and active debris removal. For this might help us to *imagine*.

8.3 Active Debris Removal, Space Activities and Prevention Obligations: *de lege ferenda*

The purpose of this cursory analysis is both to raise fundamental questions in connection with the progressive development of international law, as well as to bring to the foreground the common element of risk and its collective management. There remain *many* more questions than there are answers concerning such progressive development or an appropriate conception of risk attending space activities, of which I will especially take note in the hope of promoting more extensive debate thereon.

8.3.1 General International Environmental Law

To begin, we may refer to the general literature on international environmental law to trace the history, and to arrive at the *lex lata,* of obligations to prevent transboundary harm throughout various declarations, legal instruments and judgments by international courts and tribunals.[47] To continue, arguably the most notable modern development in this field was the pronouncement from the International Court of Justice (ICJ; Court) in its 1996 *Advisory Opinion on Nuclear Weapons*, when the Court stated that

> [t]he existence of the general obligation of States to ensure that activities within their jurisdiction and control respect the environment of other States or of areas beyond national control is now part of the corpus of international law relating to the environment.[48]

The contentious issue of nuclear weapons aside, "with the Court's decision, it was no longer possible to argue that the protection of the environment was not governed by the rules of general international law."[49]

Indeed, Article III OST renders operative the rules of general international law with regard to space activities, but it is clear that any such general obligation will need to be applicable as well on the basis of its proper substantive scope. To determine the scope of the above general obligation in relation to ADR and space activities, let us examine its constituent parts individually, as follows: (1) 'activities

[47] For example, see P. Sands, J. Peel, A. Fabra and R. MacKenzie, *Principles of International Environmental Law*, 3rd Edition, Cambridge, Cambridge University Press, 2012.

[48] Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion, *ICJ Reports* 1996, 241–242, para. 29.

[49] P. Sands, *supra* note 4, 26.

within the jurisdiction and control of a State'; (2) 'the environment of other States or of areas beyond national control'; (3) 'respect the environment'.

As to (1), 'activities within the jurisdiction and control of a State', the central question generally pertains to the appropriate attribution of particular conduct on the basis of the relevant facts in order to discern the responsible state. Straightforward attribution results from Article VI OST, pursuant to which a State Party to the OST bears international responsibility for national 'activities in outer space' by governmental agencies and non-governmental entities. Regarding especially ADR, the qualification of, for example, a 'laser'[50] or a 'sounding rocket'[51] as an 'activity in outer space' presents some difficulty, as do states not having acceded to the OST. However, in any case, recourse to generally established rules in international law for the attribution of conduct to a state[52] will render these issues largely irrelevant.[53]

As to (2): outer space, including the Moon and other celestial bodies, is not subject to national appropriation pursuant to Article II OST. This 'non-appropriation principle' extends in reach beyond its codified form as a principle of customary international law.[54] Circum-terrestrial space is thus indisputably 'an area beyond national control'.

As to (3), we can now reliably assert that there exists a general obligation under international environmental law incumbent upon every state to 'respect the environment' of outer space when undertaking space activities. Breach of this substantive rule, consisting of harm caused to the environment, would constitute a wrongful act establishing international responsibility. This obligation carries significant and specific importance. Whereas doctrinal debate on environmental protection of outer space against space debris often preoccupies itself with the wording, interpretation or role of Article IX OST, the scope of the present obligation is so expansive as to potentially obviate the need to resort almost exclusively to Article IX OST. For

[50] A number of schemes proposed to remove space debris involve the firing of a sufficiently powerful laser that ablates the leading edge of a piece of debris so as to alter its trajectory and make it re-enter the atmosphere.

[51] So-called 'just-in-time active debris removal' would utilise sounding rockets to inject certain substances in the path of a piece of debris so as to alter its trajectory at the last minute, known as 'just-in-time active debris removal' (JADR) or 'just-in-time collision avoidance' (JCA), on which see H. Schaub et al., *supra* note 24, 74.

[52] See, generally, the 2001 Draft articles on Responsibility of States for Internationally Wrongful Acts, by the International Law Commission.

[53] Speculatively, more troublesome may be those cases in which the object to be removed might also engage the responsibility of its State of registry via attribution through, *inter alia*, Article VIII on the basis of the latter's terms 'shall retain jurisdiction and control'. Insofar as the space object is seen as an 'effective link' with the State of registry, its responsibility might be engaged in certain circumstances.

[54] Some authors characterise the principle in Article II OST as *jus cogens,* while others see it as a customary rule of international law of elevated status, a 'structural norm' of international space law, on which see F. Tronchetti, "The Non-Appropriation Principle as a Structural Norm of International Law: A New Way of Interpreting Article II of the Outer Space Treaty", *Air & Space Law* 2008, Vol. 33, No. 3, 277–305.

example, while Article IX OST operates on the central determination of prejudice to the interests of a *State Party to the OST*, or of harmful interference with *activities of other States Parties*, the object enjoying the protective mandate in the general obligation is the *space environment itself*. That is not to say that the importance of Article IX OST for environmental purposes is in any way diminished. Much to the opposite: it is complemented and reinforced.[55] However, many questions endure and the proper interpretation of 'harmful interference', 'harmful contamination'[56] and 'due regard' in Article IX OST is likely to have some influence on the manner in which we interpret and qualify 'respect' for the outer space environment if the general obligation is to be properly understood, and *vice versa*.[57]

Secondly, the Court has over time developed a closely related but distinct line of reasoning on customary and general international law with regard to *procedural* and *due diligence* obligations to prevent transboundary harm,[58] that may have relevance in relation to space activities and ADR[59]:

> [T]o fulfil its obligation to exercise due diligence in preventing significant transboundary environmental harm, a State must, before embarking on an activity having the potential adversely to affect the environment of another State, [i] ascertain if there is a risk of significant transboundary harm, which would trigger [ii] the requirement to carry out an environmental impact assessment. […] If the environmental impact assessment confirms that there is a risk of significant transboundary harm, the State planning to undertake the activity is required, in conformity with its due diligence obligation, [iii] to notify and consult in good faith with the potentially affected State, where that is necessary to determine the appropriate measures to prevent or mitigate that risk.[60]

I will not dwell here on whether this exact procedural sequence is applicable to space activities or active debris removal—as we have seen, outer space is a unique environment that requires uniquely tailored rules. Rather, let us derive from the

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[55] The relationship between a treaty norm and norms extraneous to the treaty is a matter of considerable legal complexity, for which a matrix of rules for the resolution of conflict between norms may need to be invoked, on which see D. French, "Treaty Interpretation and the Incorporation of Extraneous Legal Rules", *International and Comparative Law Quarterly* 2006, Vol. 55, 281–314.

[56] For example, debate continues in the literature on whether 'harmful contamination' is limited to microparticulate matter of a more intangible nature and therefore would exclude space debris.

[57] "[T]here are situations in which the parties' intent upon conclusion of the treaty was, or may be presumed to have been, to give the terms used—or some of them—a meaning or content capable of evolving, not one fixed once and for all, so as to make allowance for, among other things, developments in international law". Dispute Regarding Navigational and Related Rights (Costa Rica v. Nicaragua), Judgment, *ICJ Reports* 2009, 242, para. 64.

[58] For example, see Corfu Channel (United Kingdom v. Albania), Judgment, *ICJ Reports* 1949, 22; Pulp Mills on the River Uruguay (Argentina v. Uruguay), Judgment, *ICJ Reports* 2010, 55–56, para. 101 and 83, para. 204; Certain Activities Carried Out by Nicaragua in the Border Area (Costa Rica v. Nicaragua) and Construction of a Road in Costa Rica along the San Juan River (Nicaragua v. Costa Rica), Judgement, *ICJ Reports* 2015, 706–707, para. 104 (hereinafter: ICJ, *San Juan River*).

[59] On which in connection with space debris and large constellations, see W. Munters, *supra* note 23.

[60] *San Juan River*, ICJ, see *supra*, note 59.

underlying logic a measure of support for the implementation of a legal 'technical framework for particular arrangements' in regard to space activities, i.e. ADR and STM. In so doing, an international system can be constructed on a legal basis that incorporates both the interests of states and operators *ex* Article IX OST and the general obligation owed to the space environment itself. The following matters deserve a closer look.

8.3.2 Prevention of Harm to the Space Environment Arising from Space Activities

Firstly, the cardinal risk to the future amenity of the circum-terrestrial space environment consists of collisions and fragmentation events resulting in critical levels of fragmentary and irremediable debris.[61] These events can have any number of causes such as 'lethal but nontrackable debris', accidental collisions, explosions or anomalies. If many of these causes elude our scientific methods of prediction and therefore our ability to prevent them, the onus to prevent the events that we *can* foresee inescapably becomes all the more exacting.[62] Such prevention mostly entails the avoidance of collisions between 'controllable' space objects *sensu stricto,* and between space objects *sensu lato*—and, of course, between both of these groups.

Sensu stricto, we might think of manoeuvrable satellites whose operator may be compelled to exert coordinated control so as to avoid collision. *Sensu lato*, we face a very broad category that encompasses any space object that can be tracked, including a wide variety of non-functional space objects ('space debris'), but also 'functional' space objects that lack any form of active or propulsive control. As to the latter, there are evident questions concerning the untenability, and thus the tenuous legality, of the utilisation of spacecraft lacking any form of propulsive means of active control, as this will, for example, force other entities to expend valuable means of propulsion in order to avoid collision.[63] As to space debris, *at least* the pieces carrying the largest risk of collision will have to be removed, or their trajec-

[61] "The future hazard from orbital debris will be largely driven by the lethal debris population (any fragment greater than 5 mm in diameter) that will be created in the thousands from hard-body-to-hard-body collisions of large objects. Therefore, although it is desirable to control the growth of the small debris population, this is best done by removing large derelict objects that might later spawn the lethal fragments through collisions." K.T. Nock et al., *supra* note 15, 369.

[62] Especially when considering "that years of successful mitigation can be negated by one collision." H. Schaub et al., *supra* note 24, 73.

[63] Consider that "[t]here is a growing population of small- and nano-satellite missions that have no propulsion capability. These missions are often high-risk technically and designed for a short mission duration. When considering all the risks that might terminate their operation, the probability of being hit by debris is not a driving consideration." H. Schaub et al., *supra* note 24, 74.

tory altered in some way,[64] in order to avoid inducing insupportable fragmentation events.

Secondly, the 'ultrahazardous' nature of space activities cannot—or should no longer—be regarded as synonymous with silent acquiescence to the significant risk that inheres in all space activities. On the contrary, it should lead to recognition of an unrebuttable presumption that space activities exceed a *de minimis* level of risk that is, *ipso facto,* to be assessed prior to, as well as for the entire duration of, a space activity on the basis of the due diligence required of every state.[65] Moreover, as I have argued, such an environmental impact assessment (EIA) cannot be undertaken effectively in a unilateral manner or without a combinatory international framework[66] that encompasses notification, consultation and coordination, dissemination of space situational awareness (SSA) data, coordinated collision avoidance manoeuvres (CAM), emergency procedures, harmonisation of models, ontologies and typologies, implementation of active debris removal (ADR), etc.

Thirdly, the facts of the matter are straightforward but daunting. Varying with orbital altitudes, we face a number of absolute thresholds that when exceeded, while difficult to precisely determine such moment *a priori*,[67] will lead to the significant impairment of utilisation of entire bands of circum-terrestrial space.[68] Proportional to orbital altitude, utility will be impaired by irremediable debris for periods spanning from days to millennia, or longer. Although the space treaties do not themselves contain an 'innovative' legal provision comparable to Article 2(1)(a) of the 2015 Paris Climate Agreement and its enumerated temperature thresholds,[69] useful

[64] For example, an 'on-orbit servicing' solution may consist of a specialised spacecraft attaching itself to the object in order to impart a continuous means of movement and control over it. Alternatively, the use of sounding rockets to inject certain substances in the path of a piece of debris so as to alter its trajectory at the last minute may be utilised—so called 'just-in-time active debris removal' (JADR) on which see *supra*, note 52.

[65] *Corfu Channel*, ICJ, *supra* note 59.

[66] *Pulp Mills*, ICJ, *supra* note 59, 83, para. 205: "it is the view of the Court that it is for each State to determine in its domestic legislation or in the authorization process for the project, the specific content of the environmental impact assessment required in each case, having regard to the nature and magnitude of the proposed development and its likely adverse impact on the environment as well as to the need to exercise due diligence in conducting such an assessment. The Court also considers that an environmental impact assessment must be conducted prior to the implementation of a project. Moreover, once operations have started and, where necessary, throughout the life of the project, continuous monitoring of its effects on the environment shall be undertaken." The authorization and continuous supervision incumbent upon the relevant state of nationality pursuant to Article VI OST bears obvious relevance here.

[67] For example, see *supra*, note 20.

[68] See quote, *supra* note 24.

[69] Article 2(1)(a) of the 2015 Paris Agreement reads: "This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by: (a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change".

analogies can be drawn from the latter in light of the prevention of irreparable harm to the space environment.

Notably, much of the difficulty surrounding the creation of effective environmental law, the adjudication of disputes arising from catastrophic environmental damage,[70] and the transformation of the rule of law itself, is to be found in the temporal tension that manifests itself in this domain and to which the machinery of international law has only a limited response. As the Court emphasised in *Gabčíkovo-Nagymaros*, "in the field of environmental protection, vigilance and prevention are required on account of the often irreversible character of damage to the environment and of the limitations inherent in the very mechanism of reparation of this type of damage".[71] The Court has nevertheless been quite reticent in developing this strand of thought more decisively, arguably because it cannot, or does not wish to, place itself in the position of an international legislator or of the body politic comprising sovereign states.

In particular, the temporal tension we face is one between an 'ex post facto' retrospective and an 'ex ante' preventive perspective in connection with the avoidance of a *fait accompli*. It is the tension between (1) the *ex post facto* determination of a breach of a substantive obligation—for example, having caused an irreparable environmental harm—and (2) an *ex ante* insistence on compliance with obligations that aim to *prevent* such harm from occurring through an articulated system of procedural rules to be observed *prior* to, and for the duration of, an activity. To be sure, if temperatures increase above a certain threshold, then human civilization will struggle. If debris accumulates in excess of a particular threshold, then Kessler Syndrome will manifest itself. These evidently are problems of such importance that allowing for even the possibility of them becoming a *fait accompli* is wholly unconscionable. So, how are we to make the rule of law operable on these problems in any meaningful sense *before they occur* and thus before traditional systems of law and adjudication can apply their hitherto largely *ex post facto* logic?

[70] For example, see the panel discussion on international liability for catastrophic environmental damage, following A. Boyle, "International Law and the Liability for Catastrophic Environmental Damage", *Proceedings of the American Society of International Law* 2011, Vol. 105, 423–430, *et seq*.

[71] Gabčíkovo-Nagymaros Project (Hungary v. Slovakia), Judgment, *ICJ Reports* 1997, 78, para. 140. In the same vein, consider: "that [the Court] has to take a forward-looking, prospective approach, engage in a comprehensive risk assessment and embrace a preventive rather than compensatory logic when determining what this risk might entail. This logic carries with it particular cogency in the realm of environmental law. […] the Court must remain aware, when confronted with challenges of risk of environmental pollution and endangerment of ecosystems, of the inherent weaknesses and flaws of the traditional retrospective judicial process and its compensatory logic." Joint Dissenting Opinion of Judges Al-Khasawneh and Simma, Pulp Mills on the River Uruguay (Argentina v. Uruguay), Judgment, *ICJ Reports* 2010, 118, para. 22 and 119, para. 24.

8.3.3 Legal Foundations for a Common Construction to Manage Risks Attending Space Activities and to Remove Debris: 'Respect for the Space Environment'

In an attempt to provide an answer, I move here partially into speculative and firmly into abstract territory, *de lege ferenda*. Let us return to one of the arguments above. Namely, that we might reasonably postulate that the prevention of the initiating conditions of a collisional cascade that would render entire orbital bands largely inhospitable to further human activity is *a universally acceptable end to be absolutely achieved*—for the alternative not only is indefensible, but arguably, for a large part, would defeat the very object and purpose of the *corpus iuris spatialis* itself. In an analogous vein, if in the future we were to collectively transgress the temperature thresholds in Article 2(1)(a) of the Paris Climate Agreement, much of the world would find itself in dire straits. This, as well, can be said to embody an 'absolute' standard against which conduct is to be assessed.

If we were to subsequently consider our postulated absolute and universal end as the *ratio legis* underlying a *singular substantive norm*—for example, expressed as 'respect the space environment'—then the latter must be an 'intransgressible' norm by its very nature, for transgression would defeat the absolute object and purpose of the norm. This 'intransgressibility' does not signify in any sense that it is impossible, in fact, to carry on those activities that would be in contravention of, or derogatory to, the substantive norm. Rather, it leads to the conclusion that the activities necessarily must be *somehow* rendered incapable of transgression or derogation. The law would thus be required to shape future conduct before, and without, having ability to *retrospectively* determine that the conduct had totally defeated our substantive norm, the absolute standard—that is, before the manifestation of a *fait accompli*. Therefore, the right moment to determine breach of the substantive norm must necessarily lie at a point in time *before* the norm has been defeated. The manner in which the law may legitimately do this is by demanding compliance with *procedural* legal obligations that aim to preventively safeguard the substantive norm and its object and purpose *before* they are defeated—*inter alia* on the basis of the due diligence and good faith required of every state. In terms of space debris and Kessler Syndrome, the attribution of wrongful conduct to a particular state will only be an effective legal means to safeguard the amenity of circum-terrestrial space when such wrongful conduct, as well as any secondary obligations of reparation emanating therefrom—for example, a secondary obligation to remove defunct space objects—is established to exist *before* such conduct has generated additional irremediable debris. In the simplest of terms, we may express this in an epigram stating that 'prevention is not better than the cure; *prevention is the cure*.'

The scathing joint dissenting opinion by judges Al-Khasawneh and Simma in the *Pulp Mills* case lends some credence to the above analysis and is especially relevant in the light of the 'elasticity' of current notions of risk attending space

activities and the concomitant absence of a common construction of that risk and its management:

> [I]n matters related to the use of shared natural resources and the possibility of transboundary harm, the most notable feature that one observes is the extreme elasticity and generality of the substantive principles involved. Permanent sovereignty over natural resources, equitable and rational utilization of these resources, the duty not to cause significant or appreciable harm, the principle of sustainable development, etc., all reflect this generality. […] Clearly in such situations, respect for procedural obligations assumes considerable importance and comes to the forefront as being an essential indicator of whether, in a concrete case, substantive obligations were or were not breached. Thus, the conclusion whereby non-compliance with the pertinent procedural obligations has eventually had no effect on compliance with the substantive obligations is a proposition that cannot be easily accepted.[72]

Our desired result of absolutely avoiding the Kessler Syndrome might then be achieved by mitigating the risk attending space activities to a sufficient degree through preventively ensuring compliant conduct in an articulated system of prior and continuous *procedural* regulation that is responsive to the variable factual circumstances surrounding space activities. That is to say, a comprehensive international procedural system founded on the legitimate rule of law, and of a level of sophistication and coordination sufficient to manage the risks to the space environment posed by space activities: an effective system for *space traffic management*. However, so long as such a *sui generis* system or alternative means of collectively managing that risk remain absent, states are not free to comport themselves as they see fit. Resort may be had in the first order to Article IX OST and to the substantive general obligation required of states to 'respect the space environment', expressed also in the procedural due diligence obligations 'to notify and consult in good faith with the potentially affected State, where that is necessary to determine the appropriate measures to prevent or mitigate that risk'.[73] Indeed, it might not be a stretch of our imagination to suspect that 'respect for the space environment' would at least entail 'respect for procedural obligations'.[74]

As discussed, the risk attending space activities (expressed here as 'probability times consequence') is of such a nature that it behoves envisioning the scope of these obligations so as to include a considerable number of affected entities to be consulted, and to coordinate with, in order to effectively mitigate the risk.[75] Any of these entities may then opt to bring proceedings against a state whose conduct appears to be in breach of its due diligence obligations, and thus the substantive obligation to respect the space environment, even prior to the contentious activity

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[72] Joint Dissenting Opinion of Judges Al-Khasawneh and Simma, *supra* note 72, 120, para. 26.

[73] *San Juan River*, ICJ, *supra* note 59.

[74] See *supra*, note 73.

[75] Crucially, the fact that Article IX OST may be considered *lex specialis* in regard to space activities and "may contain limited obligations concerning notification or consultation in specific situations does not exclude any other procedural obligations with regard to transboundary harm which may exist in treaty or customary international law." *San Juan River*, ICJ, *supra* note 59, 708, para. 108.

having been commenced in space. This is a two-way street, however. On the opposite side, an entity wishing to conduct space activities must also demand of other relevant entities, carrying on activities in space of a character to influence the risk, to enter into consultations so as to arrive at satisfactory coordinative measures, in order to effectively mitigate the aggregate risk posed to the space environment by their combined activities. If the number of consultative and coordinative relationships between entities, legally required to be established in this *ad hoc* manner for each relevant space activity, appears in any way as incalculable, we may consider it proven that an institutional space traffic management system is urgently required.

Furthermore, the official stance adopted by the United States Air Force Science Advisory Board in 1986 that "[d]ebris represents a growing problem whose seriousness depends on future traffic and debris management",[76] indicates the close correlation and complementary relationship between STM and ADR. This is hardly surprising, for the *telos* of both STM and ADR arguably is the mitigation of risk through the prevention of collisions between space objects that will produce irremediable debris—the ultimate harm to the space environment. So far as the common element of 'risk' attending space activities and its collective management are concerned, ADR and STM are simply two sides to the same coin. Indeed, not only is the above procedural constellation of legal obligations directly applicable to removal activities, removal activities themselves would appear to emerge therefrom as compulsory.

Tentatively, any state that retains jurisdiction and control over a defunct space object pursuant to Article VIII OST or responsibility for national space activities on the basis of Article VI OST—alternatively, the state that is internationally responsible pursuant to general rules for the attribution of particular conduct—will act in breach of the substantive obligation to respect the space environment so long as it neglects to remove that object[77] *ipso facto* carrying a risk of collision. Insofar as it is impossible to precisely predict when a collision might occur, *inter alia* due to collisional hazards posed by nontrackable debris or due to the imprecision of statistical models of the space object population for the calculation of collisional risk, the breach must be assumed to occur after passage of a reasonable yet brief period of time, commencing from the moment a space object becomes defunct—or, by extension, uncontrollable. Once that period has elapsed, the international responsibility of the relevant state will have been engaged, whereupon the secondary obligation of reparation ideally will entail rapid compulsory removal of the object or the reestablishment of effective control through on-orbit servicing.[78] Once more, we might

[76] As quoted in W.B. Wirin, *supra* note 18, 184.

[77] It is widely accepted that wrongful conduct by a state can consist of an act or of an omission, on which see *supra*, note 53.

[78] It is doubtful whether such a form of reparation is technically possible at present or not too disproportionately costly in any case, thereby precluding application of an obligation of restoration to the *status quo ante*, on which see W. Munters, *supra* note 23. This will heighten the importance of adherence to mitigative measures such as post-mission disposal and also should entail, at a very minimum, a more stringent obligation to update the status of the space object in the registry held by the United Nations Secretary General and UNOOSA. Under this legal construction, compensation may likely also be claimed under the Liability Convention by any entity having to expend propul-

look to 50-year old space law doctrine, stating that "[b]efore long it will become mandatory for states to remove from orbit unmanned space vehicles and debris that pose a hazard to spacecraft navigation".[79]

Finally, if space activities *sensu lato* are beset by significant risks, then active removal constitutes an *especially* risky activity. The relevant obligations to notify, consult and coordinate are thus engaged in an arguably even stricter manner. This adds considerable weight to proposals in the literature for an international organisation related to ADR.[80] Moreover, some proposed means by which to perform removal activities carry an increased risk over others, and obligations may have some role to play as to circumscribing the reasonable choice of the technology to be employed. In addition, we might expect the high level of risk inherent in ADR to necessitate an extremely precautious approach to removal activities;[81] one that extends in ambit well beyond the risk to the space environment. The recent example of the re-entry into Earth's atmosphere by the Chinese Tiangong-1 spacecraft serves to remind us of the risk posed on Earth by the wholesale removal of objects from space into the atmosphere in the near future. An impressive international coalition of space agencies and the IADC closely monitored the object's re-entry. Apart from the obvious argument for increased international cooperation and coordination, it will be borne in mind that removal activities can and will fail to adhere to best-case scenarios for their successful completion. As a result of possible failure, additional debris might either be created in orbit, or pieces of debris might survive re-entry over populated areas.[82] Therefore, let us fully accept that a plethora of fundamental questions related to the many risks attending space activities and its collective management are still to be resolved. Perhaps now is the time for us to start answering them.

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sive means—placing considerable cost on the entity—for acting in breach of a substantive obligation will lead to the establishment of fault on the part of the state acting in a wrongful manner.

[79] C.R. Hall, "Comments on Salvage and Removal of Man-made Objects from Outer Space", *Journal of Air Law and Commerce* 1967, Vol. 33, 288. See also W.B. Wirin, *supra* note 18, 184.

[80] On which see W. Munters and J. Wouters, "The Road Not Yet Taken for Defusing Conflict in Active Debris Removal: a Multilateral Organisation", in M. Manoli and S.B. Habchi (Eds.), *Monograph Series IV: Conflicts in Space and the Rule of Law*, Montreal, McGill Centre for Research in Air and Space Law, 2017, 145–171.

[81] Although this might have been understated in the current chapter due to a lack of scope, the tentative application of a precautionary approach or a legal precautionary principle to space activities bears consideration and should not be summarily dismissed on the basis of a 'sound science' approach to risk. We can foresee considerable difficulty, however, since "while scientific methodologies can be employed in order to disclose uncertainties and value judgments in a transparent fashion, they also lend themselves to misuse for political ends." On competing risk regulatory paradigms and the distinction, or otherwise, between "sound science and precautionary principle risk regulatory paradigms", as well as for quotes herein, see J. Peel, *Science and Risk Regulation in International Law*, Cambridge, Cambridge University Press, 2010, 151, *et seq*. See also *supra*, note 19.

[82] Consider that "if falling debris causes a death, it may significantly alter the discussion about liability, especially in the effected [sic] country. As a result, operators must consider the risk and political cost of deorbiting an object and the risk of doing terrestrial damage, versus the risk of leaving the object in space for many decades." H. Schaub et al., *supra* note 24, 72.

8.4 Concluding Remarks

Over the course of the preceding pages I have attempted to demonstrate, and legally motivate, the urgent need for the international community to arrive at a common construction of the risk attending space activities and of the manner in which to collectively manage it.

How to *precisely* define, calculate, manage or even just conceptualise such an abstract notion of risk so as to render it operable to a sufficient degree is an altogether different matter of staggering complexity. It requires simultaneous and continuous input from a host of different disciplines and spacefaring entities. But it would appear to be self-evident that it will prove difficult not to improperly discount the role of risk in connection with mankind's activities in outer space so long as different entities wield divergent, and perhaps incommensurable, notions of risk, of its sustainable thresholds, or of the effective process for the management thereof.

As concerns the management of that risk, I have noted the especially close relationship between space traffic management (STM) and active debris removal (ADR). They are simply two sides to the same coin, and they are inseparable insofar as they aim to prevent the cardinal risk posed by collisions between space objects—and thereby to prevent irreparable harm to the space environment. Although it is difficult to draw the line between *lex lata* and *lex ferenda* in international environmental and space law, at present it is plausible that legal obligations can be said to exist that not only (1) compel states to closely consult and coordinate with each other when carrying on space activities—much more closely than is the case today—but that also (2) impose a duty to remove defunct or uncontrollable objects. Perhaps the time has come for those interested in preserving the utility of the most valuable, and therefore most populous parts, of circum-terrestrial space to seek to enforce those obligations. At least, *one can imagine*.

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Chapter 9
United States Law and Policy on Space Debris

Zhuang Tian

Abstract The purpose of this article is to analyze how the problem of space debris is dealt with on the national level. The law and policy of the U.S. will serve as an example for such analysis. The U.S. has established a comprehensive legal regime and has promulgated several national policies to confront the space debris challenge. The function of implementation and regulation of space activities is divided among several national agencies in the U.S. Each agency has developed its own rules and standards on space debris. These rules and standards conform to the best practices as contained in the space debris mitigation guidelines. On the policy level, it has been three decades since the issue of space debris was first mentioned in U.S. national space policy, and there has been a constant concern over space debris ever since. The evolution of U.S. national space policy on space debris can be summarized as from interior to exterior, from general to elaborate, and from debris mitigation to debris remediation.

9.1 Introduction

With the growing number of space activities and space actors, the problem of space debris may further deteriorate. At the 56th session of the Committee on the Peaceful Uses of Outer Space (COPUOS) in 2013, the Committee urged states to implement space debris mitigation measures consistent with the IADC Guidelines[1] and

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[1] Inter-Agency Space Debris Coordination Committee (IADC) Space Debris Mitigation Guidelines, referred to in this note as the IADC Guidelines.

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COPUOS Guidelines[2] or to develop their own space debris mitigation standards based on those guidelines.[3] An analysis of national space law and policy may illustrate to what extent these guidelines are implemented. As commented by Gunnar Leinberg, any international resolution regarding space debris should consider the current space policies of various spacefaring nations.[4] An analysis of those policies will help recognize the various interests that need to be recognized and will help focus any international discussions.[5] This note aims to analyze how the issue of space debris is addressed on the national level. To this end, the case of the U.S. will be used as an example.

9.2 Agency Responsible for the Regulation of Space Activities

The U.S. has divided the function of implementation and regulation of space activities among several governmental agencies, as follows:

The National Aeronautics and Space Administration (NASA), which is the leading federal agency performing research, technology, and development of aeronautical and space science, exploration, and application;

The Department of Transportation (DOT), which licenses and promotes commercial launch operations, issues launch and payload approvals in conjunction with other agencies, such as the Federal Communications Commission (FCC), which regulates radio frequencies for telecommunications, broadcasting and other purposes;

The Department of Commerce (DOC), whose National Oceanic and Atmospheric Administration (NOAA) engages in remote sensing, gathers data, conducts research, and makes predictions about the Earth's environment, and whose Office of Space Commercialization coordinates space-related issues and programs within DOC; and

The Department of Defense (DOD), which uses space for intelligence gathering, communications, and potentially, for missile defense.[6]

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[2] Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, referred to in this note as the COPUOS Guidelines.

[3] UN Doc. A/68/20, Report of the Committee on the Peaceful Uses of Outer Space, Fifty-sixth session (12–21 June 2013).

[4] Gunnar Leinberg, *"Orbital Space Debris.*" JL & Tech. 4 (1989): 94.

[5] *Id*.

[6] Paul Stephen Dempsey. *"Overview of the United States Space Policy and Law."* National Regulation of Space Activities. Space Regulations Library; Vol. 5. 238232972. New York, NY [etc.]: Springer (2010): 373–374.

9.3 U.S. Policy on Space Debris

Policies of the U.S. government regarding space can be found in both the language of statutes promulgated by Congress (wherein the Congress declares national policy), and in directives, executive orders and other communications of the President.[7]

Beginning in 1984 with the Commercial Space Launch Act, and continuing through the present with NASA and DOD efforts to reduce debris and move inoperative satellites out of high-demand orbits, the U.S. has made debris reduction an important objective of its space policy.[8] In 1988, the issue of space debris was first mentioned in the national space policy of the Reagan Administration, which stated that,

> [A]ll space sectors will seek to minimize the creation of space debris. Design and operations of space tests, experiments and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements and cost-effectiveness.[9]

Noting the lack of good measurements of the orbital debris environment, the U.S. government issued a report on orbital debris in the following year, calling for the NASA and the DOD to develop a plan to monitor the debris environment.[10] This report was updated in 1995, issuing five recommendations for the mitigation of space debris.[11]

Reiterating what had been mentioned in the previous national space policy, the national space policy issued by the Bush Administration in 1989 added that,

> The United States government will encourage other spacefaring nations to adopt policies and practices aimed at debris minimization.[12]

The mitigation of space debris was also identified as one of the priority intersector guidances to support major U.S. space policy objectives in the national space policy issued by President Clinton in 1996.[13] In addition to reaffirming the earlier policy by calling for U.S. government agencies to minimize the creation of space debris, the 1996 Policy also required NASA, the intelligence community, and DOD, in cooperation with the private sector, to develop design guidelines for future Government procurements of spacecraft, launch vehicles, and services. Moreover,

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[7] *Id*. at 373.

[8] NASA Policy Directive 8710, Policy to Limit Orbital Debris Generation; U.S. Space Command (USSPACECOM) Regulation 57-2, Minimization and Mitigation of Space Debris (Jun. 6, 1991). Elizabeth Seebode Waldrop, *"Integration of Military and Civilian Space Assets: Legal and National Security Implications."* 55 A.F. L. Rev. 157, 232 (2004): 212.

[9] Presidential Directive on National Space Policy, dated 11 February 1988 (Reagan era).

[10] The Federal Aviation Administration (FAA), *"Launch Activity and Orbital Debris Mitigation"*. Second Quarter 2002 Quarterly Launch Report, at 11.

[11] *Id*.

[12] National Space Policy Directives and Executive Charter, NSPD-1, dated 2 November 1989 (G.H.W. Bush era).

[13] Presidential Decision Directive, National Space Policy, NSTC-8, dated 19 September 1996 (Clinton era).

the 1996 Policy mentioned that the U.S. Government would take a leadership role in international forums to adopt policies and practices aimed at debris minimization.[14]

On 31 August 2006, President Bush authorized a new national space policy that established an overarching national policy to govern the conduct of U.S. space activities, which superseded the previous national policy of 1996.[15]

In recognizing the risks imposed by space debris, the 2006 policy stated that the U.S. should seek to minimize the creation of orbital debris by government and non-government operations in space to preserve the space environment for future generations.[16] Towards that end:

> Departments and agencies shall continue to follow the United States Government Orbital Debris Mitigation Standard Practices, consistent with mission requirements and cost effectiveness, in the procurement and operation of spacecraft, launch services, and the operation of tests and experiments in space;
>
> The Secretaries of Commerce and Transportation, in coordination with the Chairman of the Federal Communications Commission, shall continue to address orbital debris issues through their respective licensing procedures; and
>
> The United States shall take a leadership role in international fora to encourage foreign nations and international organizations to adopt policies and practices aimed at debris minimization and shall cooperate in the exchange of information on debris research and the identification of improved debris mitigation practices.[17]

The latest National Space Policy was issued by the Obama Administration on 28 June 2010, which provided comprehensive guidance for all government activities in space, including the commercial, civil, and national security space sectors.[18]

In its introduction, the policy states that "decades of space activity have littered Earth's orbit with debris," which "can have damaging consequences for all of us," owing to "the now ubiquitous and interconnected nature of space capabilities and the world's growing dependence on them."[19] It further states that,

> As the leading space-faring nation, the United States is committed to addressing these challenges. But this cannot be the responsibility of the United States alone. All nations have the right to use and explore space, but with this right also comes responsibility. The United States, therefore, calls on all nations to work together to adopt approaches for responsible activity in space to preserve this right for the benefit of future generations.[20]

One of the goals the U.S. would pursue in its national space program as set in the 2010 Policy is the strengthening of measures to mitigate orbital debris.[21] Moreover,

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[14] FAA, *supra* note 11, at 10.

[15] National Space Policy, dated 31 August 2006 (G. W. Bush era).

[16] *Id.*

[17] *Id.*

[18] National Space Policy of the Unite States of America, dated 28 June 2010 (Obama era). *See* http://www.space.commerce.gov/policy/national-space-policy.

[19] *Id*. at 1.

[20] *Id*. at 2.

[21] *Id*. at 4.

the Policy identifies space surveillance for debris monitoring and awareness as an area for potential international cooperation.[22] The most relevant guideline concerns the preservation of the space environment, which stated that,

> For the purposes of minimizing debris and preserving the space environment for the responsible, peaceful, and safe use of all users, the United States shall:
>
> Lead the continued development and adoption of international and industry standards and policies to minimize debris, such as the United Nations Space Debris Mitigation Guidelines;
>
> Develop, maintain, and use space situational awareness (SSA) information from commercial, civil, and national security sources to detect, identify, and attribute actions in space that are contrary to responsible use and the long-term sustainability of the space environment;
>
> Continue to follow the United States Government Orbital Debris Mitigation Standard Practices, consistent with mission requirements and cost effectiveness, in the procurement and operation of spacecraft, launch services, and the conduct of tests and experiments in space;
>
> Pursue research and development of technologies and techniques, through the Administrator of the National Aeronautics and Space Administration (NASA) and the Secretary of Defense, to mitigate and remove on-orbit debris, reduce hazards, and increase understanding of the current and future debris environment; and
>
> Require the head of the sponsoring department or agency to approve exceptions to the United States Government Orbital Debris Mitigation Standard Practices and notify the Secretary of State.[23]

It was the first time that the removal of space debris was addressed on the national space policy level. The 2010 Policy reveals an increasing concern of the U.S. about debris remediation. In fact, the concept of debris removal has already been mentioned in another U.S. policy in 2005. The Transportation Policy of 2005 stated that "the United States shall … pursue research and development of in-space transportation capabilities … including but not limited to: automated rendezvous and docking, and the ability to deploy, service, and retrieve payloads or spacecraft in orbit".[24]

To foster the development of space collision warning measures, the 2010 Policy further stated that,

> the Secretary of Defense, in consultation with the Director of National Intelligence, the Administrator of NASA, and other departments and agencies, may collaborate with industry and foreign nations to: maintain and improve space object databases; pursue common international data standards and data integrity measures; and provide services and

[22] *Id*. at 7.

[23] *Id*. at 7–8.

[24] UN Doc. A/AC.105/C.1/2012/CRP.16, *"Active Debris Removal — An Essential Mechanism for Ensuring the Safety and Sustainability of Outer Space, A Report of the International Interdisciplinary Congress on Space Debris Remediation and On-Orbit Satellite Servicing."* (27 January 2012) (hereinafter referred to as the Report on ADR and OOS) at 37. *See* http://www.unoosa.org/pdf/limited/c1/AC105_C1_2012_CRP16E.pdf.

> disseminate orbital tracking information to commercial and international entities, including predictions of space object conjunction.[25]

From a broader picture, there is a great difference between the 2006 Policy and the 2010 Policy, which concerns Anti-Satellite weapons (ASAT) and is thus relevant to space debris. The 2006 Policy stated that the U.S. government "rejects any limitations on the fundamental right of the United States to operate in and acquire data from space," a phrase that was interpreted as giving the green light to the development and use of anti-satellite weapons.[26] The 2006 Policy also stated that Washington would "oppose the development of new legal regimes or other restrictions that seek to prohibit or limit U.S. access or use of space," a phrase that effectively ruled out arms control.[27]

According to an administration official, who spoke on the condition of anonymity, "this policy is not about developing or deploying weapons in space."[28] The official further said that new arms control agreements were not needed because there is no space arms race.[29] Nevertheless, skepticism remains.[30] In fact, there are some allegations that, in secret, the Bush administration engaged in research that critics said could produce a powerful ground-based laser, among other potential weapons meant to shatter enemy satellites in orbit.[31]

By contrast, the 2010 policy renounced the unilateral stance of the Bush administration and instead emphasized international cooperation, including the possibility of an arms control treaty that would limit the development of space weapons.[32] In its principles, the new policy stated that,

> It is the shared interest of all nations to act responsibly in space to help prevent mishaps, misperceptions, and mistrust. The United States considers the sustainability, stability, and free access to, and use of, space vital to its national interests. Space operations should be conducted in ways that emphasize openness and transparency to improve public awareness of the activities of government, and enable others to share in the benefits provided by the use of space.[33]

This principle focuses on the transparency and confidence-building, as well as the sustainability and stability of space, both of which will contribute to the mitigation of space debris.

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[25] National Space Policy of the Unite States of America (2010), *supra* note 19, at 8.

[26] William J. Broad and Kenneth Chang, *"Obama Reverses Bush's Space Policy"*. 28 June 2010. *See* http://www.nytimes.com/2010/06/29/science/space/29orbit.html.

[27] *Id*.

[28] Joan Johnson-Freese, *"Space as a Strategic Asset."* Columbia University Press (2007): 237.

[29] *Id.*

[30] *Id*.

[31] William J. Broad and Kenneth Chang, *"Obama Reverses Bush's Space Policy"*. 28 June 2010. *See* http://www.nytimes.com/2010/06/29/science/space/29orbit.html.

[32] *Id*.

[33] National Space Policy of the Unite States of America (2010), *supra* note 19, at 3.

9.4 U.S. Law on Space Debris

With the division of regulatory authority of space activities among several agencies, the function of regulating space debris is divided accordingly. The rules, standards, and guidelines of NASA and DOD has been examined extensively by Michael W. Taylor.[34] Moreover, NASA and DOD are in charge of civil and military space activities respectively, which are not the focus of this paper. Hence, emphasis will be put on the rules and requirements of DOT, DOC, and FCC, the three agencies that are authorized to license commercial space activity.[35]

9.4.1 Debris Mitigation Under FCC

The FCC is the U.S. agency responsible for licensing radio transmissions by private entities, including transmissions by satellite.[36] In June of 2004, the FCC adopted a comprehensive set of regulations concerning mitigation of orbital debris, which applies to the licensing of commercial U.S. satellites and to the use of non-U.S. satellites to provide service in the U.S.[37] The rules require submission, prior to authorization, of a description of the design and operational strategies the satellite system will use to mitigate orbital debris.[38] This information will be examined by the FCC to determine whether "the public interest, convenience, and necessity will be served by the granting of such application" before issuance of any license.[39] FCC regulations also require that geostationary satellites be relocated at end-of-mission in accordance with the IADC guideline, and all satellites must discharge stored energy sources at end-of-mission.[40]

The above-mentioned disclosure and operational requirements can be roughly classified into three categories: (a) disclosure concerning collision avoidance measures with other large objects during normal operations; (b) disclosure and operational requirements concerning post-mission disposal, including the de-orbiting of

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[34] Michael W. Taylor, *"Orbital Debris: Technical and Legal Issues and Solutions."* Thesis submitted to Institute of Air and Space Law, McGill University, Montreal, August 2006: 52–59.

[35] Mark K. Sundahl, *"Regulating Non-traditional Space Activities in the United States in the Wake of the Commercial Space Launch Competitiveness Act."* Air and Space Law 42, No. 1 (2017): 31.

[36] K. Kensinger, S. Duall, and S. Persaud, *"The United States Federal Communications Commission's Regulations Concerning Mitigation of Orbital Debris."* Proceedings of the 4th European Conference on Space Debris (ESA SP-587), at 571.

[37] *Id*.

[38] 47 CFR § 5.64(b), § 25.114(c)(14), § 97.207(g)(1).

[39] 47 U.S.C. § 309—Application for license. *See also* "the United States of America - UNOOSA Compendium of space debris mitigation standards adopted by States and international organizations (UNOOSA Compendium)." http://www.unoosa.org/oosa/en/ourwork/topics/space-debris/compendium.html.

[40] 47 CFR § 25.283 End-of-life disposal. *See also* the United States of America—UNOOSA Compendium, *id*.

geostationary satellites and the discharge of stored energy sources; and, (c) disclosure concerning assessment and analyses designed to prevent the space objects from becoming a source of debris, either through planned operations or through system failure during normal operations,[41] as well as spacecraft shielding to prevent loss of control due to collision with small debris, efforts to minimize explosions, and control of debris released during normal operations.[42]

All the seven UN Guidelines can find their origins in the above requirements which reflect the "best practice" nature of these guidelines. Indeed, the FCC's rules and policies incorporate the latest recommendations of the IADC and ITU and thus provide a comprehensive framework for review and regulation of the debris mitigation practices of commercial spacecraft operations.[43]

9.4.2 Debris Mitigation Under NOAA

On 18 December 2010, President Barack Obama signed PL 111-34 (H.R.) 3237 into law, which promulgated Title 51 of the United States Code (U.S.C.), entitled *National and Commercial Space Programs*, and is the compilation of the general laws governing space programs.[44]

Subtitle VI of the National and Commercial Space Programs law, titled *Earth Observations* (referred to this note as the Earth Observations Act) applies to all U.S. operators of commercial remote sensing satellites. According to the Earth Observations Act, a license is a prerequisite for the operation of private remote sensing spacecraft.[45] To obtain such a license, one of the conditions is that the licensee shall, upon termination of operations under the license, make disposition of any satellites in space in a manner satisfactory to the President.[46] Moreover, written compliance with U.S. orbital debris and disposal policies and best practices is also a prerequisite for obtaining a license.[47]

NOAA issues regulations establishing the agency's requirements for the licensing, monitoring and compliance of operators of private Earth remote sensing space systems under the Earth Observations Act.[48] These regulations implement the provisions of the Earth Observations Act and the 2003 U.S. Commercial Remote Sensing Policy.[49]

Under these requirements, space debris is defined as all human-generated debris in Earth orbit, which includes, but is not limited to, payloads that can no longer

[41] Kensinger, *supra* note 37, at 572.

[42] *Id*.

[43] *Id*. at 575.

[44] Rupert W. Anderson. *"The Cosmic Compendium: Space Law."* Lulu. com (2015): 94.

[45] 51 U.S.C. § 60122 (2012).

[46] *Id*.

[47] The United States of America—UNOOSA Compendium, *supra* note 40.

[48] *Id*.

[49] *Id*.

perform their mission, rocket bodies and other hardware (e.g., bolt fragments and covers) left in orbit as a result of normal launch and operational activities, and fragmentation debris produced by failure or collision.[50] Gases and liquids in free state are not considered orbital debris.[51]

The licensing requirement that the licensee shall, upon termination of operations under the license, make disposition of any satellites in space in a manner satisfactory to the President, is interpreted by NOAA as meaning that a licensee shall assess and minimize the amount of orbital debris released during the post-mission disposal of its satellite.[52] Applicants are required to provide at the time of application a plan for post-mission disposition of remote sensing satellites.[53] NOAA will review an applicant's plan for post-mission disposal on a case-by-case basis, to assess whether the plan, including satellite design and components, provides an acceptable post-mission disposal method to mitigate orbital debris and minimize any potential adverse effects.[54] Applicants are specifically required to submit a casualty risk assessment if planned post-mission disposal involves atmospheric re-entry of the spacecraft.[55]

9.4.3 Debris Mitigation Under DOT

The FAA, under the purview of the DOT, is responsible for issuing licenses to persons launching a launch vehicle from U.S. launch sites, reentering a reentry vehicle to U.S. sites, or operating a launch or reentry site within the U.S.[56] The FAA issues licenses to commercial launch vehicles after a rigorous evaluation of the safety of the launch system, and revokes licenses or imposes a fine if at any time the license holder does not comply with the conditions of the license and the FAA orbital debris mitigation regulations.[57]

The current FAA orbital debris mitigation regulations focus on safety at the end of launch, which is defined by the FAA as the last exercise of control over the launch vehicle.[58] In Title 14 of the Code of Federal Regulations (CFR) § 415.39, the FAA requires expendable launch vehicle (ELV) launch license applicants to demonstrate that: (1) there will be no unplanned contact between the vehicle, its components,

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[50] NOAA. 15 CFR Part 960 Licensing of Private Land Remote-Sensing Space Systems; Final Rule, at 24483. *See* http://library.blountsfolly.com/space/files/original/43aef50ff3d49db534edb230ede8179e.pdf.

[51] *Id*.

[52] *Id*. at 24479.

[53] *Id.*

[54] *Id.*

[55] *Id*.

[56] 14 CFR § 413.3 (b).

[57] The United States of America—UNOOSA Compendium, *supra* note 40.

[58] *Id*.

and payload after payload separation; (2) no debris will be generated from the conversion of chemical, pressure, and kinetic energy sources into energy that fragments the vehicle or its components; and (3) stored energy must be removed by depleting residual fuel and leaving all fuel line valves open, venting any pressurized system, leaving all batteries in permanent discharge state, and removing any remaining source of stored energy.[59] While § 415.39 applies to ELVs, 14 CFR § 431.43 specifies that the first two of the above stipulations apply to reusable launch and re-entry vehicles, and also requires a reusable vehicle operator to perform a collision avoidance analysis to ensure a 200-km separation between the vehicle and an inhabitable orbiting object during launch and re-entry.[60]

In sum, the FAA requires the limitation of space debris released during launch, the use of safe energy, and the minimization of potential for post-mission break-ups resulting from stored energy. However, the FAA does not require the de-orbit or re-orbit of upper stages.

9.4.4 Debris Mitigation Under NASA

NASA has developed a framework of requirements for limiting debris creation by NASA-related payloads, instruments, launch vehicles, and mission-related debris.[61] An update to the NASA Procedural Requirements (NPR) for Limiting Orbital Debris and Evaluating the Meteoroid and Orbital Debris Environment, NPR 8715.6B, became official on 15 February 2017.[62] NPR 8715.6B replaced the previous version, NPR 8715.6A with Change 1, which was released on 25 May 2012.[63]

The purpose of the NPR is to define various roles, responsibilities, and requirements to ensure that NASA, including its mission partners, providers, and contractors, takes steps to preserve the near-Earth space environment, in accordance with the U.S. National Space Policy and the U.S. Government Orbital Debris Mitigation Standard Practices to mitigate the risk to space missions and human life due to orbital debris and meteoroids.[64] The new NPR contains several key changes, among which two require particular attention. First, concerning its applicability, "this NPR is applicable to programs and projects responsible for NASA or NASA-sponsored objects launched into space to the extent that Federal authority to oversee the mitigation of orbital debris for those missions or portions thereof does not reside with another Federal department or agency."[65] In other words, its applicability is limited

[59] FAA, *supra* note 11, at 11.

[60] *Id*.

[61] NASA, *"Orbital Debris Quarterly News."* Volume 21, Issue 2, May 2017, at 1.

[62] *Id*.

[63] *Id.*

[64] *Id*.

[65] Art. 2(b), NPR 8715.6B.

to missions that do not fall under the regulatory authority of another U.S. federal department or agency.[66] Second, this new NPR establishes a process to notify the Secretary of State for any non-compliance with the U.S. Government Orbital Debris Mitigation Standard Practices, as required by the 2010 U.S. National Space Policy.[67] Such Standard Practices will be discussed below.

9.5 U.S. Space Debris Mitigation Standard

In 1997, an interagency working group led by NASA and DOD created a set of *U.S. Government Orbital Debris Mitigation Standard Practices* (referred to in this note as the "Standard Practices").[68] The Standard Practices were presented to U.S. industry in 1998, and after further consultation with industry, the Standard Practices were adopted in February 2001.[69] Based on a NASA safety standard of procedures for limiting debris, the Standard Practices are intended for government-operated or procured space systems, including satellites as well as launch vehicles.[70] The interagency working group has shared the guidelines with the aerospace industry to encourage voluntary compliance.[71]

The Standard Practices cover all program phases, from initial concept development to space hardware disposal, focusing on: the minimization of intentional debris releases and the occurrence of accidental explosions; the avoidance of hazardous collisions; and, responsible disposal of space hardware.[72] They serve as the overall U.S. Government space debris mitigation technical guidance and as the foundation for specific orbital debris mitigation requirements issued by individual U.S. government departments and agencies.[73]

9.6 Conclusion

At the 53rd session of the UN COPUOS Scientific and Technical Subcommittee, many Member States expressed concern at the challenges presented by space debris.[74] The U.S. statement on Space Debris emphasized the importance of the UN

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[66] NASA, *supra* note 62, at 1.

[67] *Id*.

[68] FAA, *supra* note 11, at 10.

[69] The United State of America—UNOOSA Compendium, *supra* note 40.

[70] FAA, *supra* note 11, at 10.

[71] *Id.*

[72] The United State of America—UNOOSA Compendium, *supra* note 40.

[73] *Id*.

[74] NASA, *"Orbital Debris Quarterly News."* Volume 20, Issues 1 & 2 April 2016, at 5.

Guidelines and called on all space-faring nations and organizations to implement these guidelines to limit the generation of space debris.[75]

As a reflection of the U.S. position at international level, the U.S. has issued several policies and established a comprehensive legal regime to confront the space debris challenge. The evolution of the national space policy concerning space debris can be summarized as from interior to exterior, from general to elaborate, and from debris mitigation to debris remediation.

From interior to exterior means that, in the beginning, the policy only required all space sectors to seek to minimize the creation of space debris. Subsequently, a policy was added which required the U.S. government to encourage other spacefaring nations to adopt policies and practices aimed at debris minimization. These two policies, with some slight adjustment made in the following policies, constitute two cornerstones of U.S. policy concerning space debris.

From general to elaborate means that, at the outset, only some general requirements were stated, e.g., requirements to "seek to minimize" or "strive to minimize" the generation of space debris, without specifying how these shall be fulfilled. Those general requirements are elaborated in the following policies, especially the 2010 Policy. From an administrative perspective, the 2010 Policy requires that the head of a sponsoring department or agency must specifically approve any exceptions to the Standard Practices and notify the Secretary of State.[76] From a technical perspective, the 2010 Policy emphasized on the development, maintenance and use of space situational awareness (SSA) information, as well as the development of space collision warning measures.[77]

From debris mitigation to debris remediation means that the concept of debris removal now appears on the national space policy level. According to the 2010 National Space Policy, the United States shall pursue research and development of technologies and techniques, through the Administrator of NASA and the Secretary of Defense, to mitigate and remove on-orbit debris.[78]

The impetus for the U.S. to play a leading role in space debris mitigation may be originated from its national interests. By possessing the most mature commercial space industry as well as the most advanced space technology in the world, the U.S. is the most capable nation to reap economic, political and social benefits from space applications, and the most technologically enabled state to carry out space debris mitigation maneuvers. Indeed, what the U.S. does in this regard is consistent with the overall interests of the international community. To slow down and even to reverse the growth trends of space debris, the whole world shall make efforts in this direction.

Licensing procedures are the main tool used by the U.S. to regulate and supervise the creation of space debris in commercial space activities. Several agencies are

[75] *Id*.

[76] National Space Policy of the Unite States of America (2010), *supra* note 19, at 8.

[77] *Id.* at 7–8.

[78] *Id.* at 7.

involved in this regulation: the FCC authorizes the use of radio spectrum for telecommunications as well as the use of orbital slots by satellites; the DOT (through the FAA) exercises authority over the launch and reentry of spacecraft, but its authority does not extend to activities in orbit or beyond; and the DOC (through NOAA) exercises authority over remote sensing of the Earth from space.[79] These agencies have established their licensing requirements for commercial space activities respectively, with space debris mitigation being one of these requirements.

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[79] Sundahl, *supra* note 36, at 31.

Chapter 10
The Finnish Space Activities Act and Active Debris Removal

Maija Lönnqvist

Abstract The Finnish Act on Space Activities entered into force on 23 January 2018. The Act was signed by the President the same day as the first commercial Finnish satellite was launched to outer space. The objective of the new Act is to create a predictable and legally transparent environment for national space activities and to ensure the safety of the activities as well as the sustainable use of outer space.

10.1 Introduction

Finland has just enacted the national Act on Space Activities.[1] The Act was proposed by the Government to the Parliament at the end of October, accepted by the Parliament at the end of December 2017 and, following confirmation by the President, entered into force on 23 January 2018. The Act is complemented by a Decree of the Ministry of Economic Affairs and Employment, which entered into force the same day. Before the new Act and Decree, there was no legislation to regulate activities related to the launching and operating of satellites.

The development of the Finnish space sector made it important to define preconditions for space activities at the level of legislation. The first Finnish nanosatellite, AALTO I,[2] by Aalto University, was launched in June 2017 and there are several plans for other nanosatellites, also on a commercial basis. By coincidence, the first commercial Finnish satellite, Iceye X-1 by Iceye Ltd,[3] was launched on 12 January 2018, the same day as the President of Finland signed the new Act on Space Activities.

[1] More information on Finnish space law and space policy in http://tem.fi/en/space.

[2] http://aalto1.fi/aalto1_in_english.html.

[3] https://www.iceye.com/. See also http://www.bbc.com/news/science-environment-42648391#.

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Finland has been a state party to three of the five UN space treaties[4] since the 1970s: the Outer Space Treaty, the Liability Convention, and the Rescue Agreement. In parallel to the new Act, Finland acceded to the UN Registration Convention in January 2018. There is no intention currently to accede to the Moon Agreement. Through the new Act, the obligations of UN treaties are among the responsibilities of operators of space activities.

The objective of the new legislation is to define the rights, obligations and responsibilities of different actors, to create a predictable and legally transparent environment for national space activities, and to ensure that the state is kept aware of all space activities practised in its territory and by its nationals. The intention is to create a flexible authorization process that enhances the development of new technologies and business opportunities.

The Act follows the established international practice and is built on the so-called building blocks as introduced in UN resolution 68/74 of 2013, "Recommendations on National Legislation Relevant to the Peaceful Exploration and Use of Outer Space as well as the ILA Sofia Guidelines for a Model Law on National Space Legislation".[5] Thus it contains provisions on authorization of space activities and conditions for authorization, registration of space objects, liability and regress right, transfers, and supervision as well as space debris.

The Act was prepared by a working group established by the Ministry of Economic Affairs and Employment.[6] The members of the working group represented the relevant ministries and governmental agencies, universities and industry—their expertise ranging from space technology and research to law and business.

10.2 Summary of the Provisions of the Act

The scope of the Finnish act on space activities is space activities within the territory of Finland or on vessels or aircraft registered in Finland, as well as space activities by Finnish citizens or by legal persons incorporated in Finland.[7] The Act applies to both governmental and non-governmental space activities. However, provisions

[4] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (Outer Space Treaty); Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Rescue Agreement); Convention on International Liability for Damage Caused by Space Objects (Liability Convention); Convention on Registration of Objects Launched into Outer Space (Registration Convention); Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement).

[5] UN document A/AC.105/C.2/2013/CRP.6 in http://www.unoosa.org/pdf/limited/c2/AC105_C2_2013_CRP06E.pdf (22.1.2018).

[6] Press release: https://tem.fi/artikkeli/-/asset_publisher/tyoryhma-valmistelemaan-kansallista-avaruuslainsaadantoa?_101_INSTANCE_KbgSvtizPgsM_languageId=en_US.

[7] Section 1 of the Act on Space Activities.

on authorization, insurance and supervision are not applied to space activities by the national defence forces.[8]

According to the Act, *space activities* means launching space objects into outer space, operation and control of space objects in outer space, and returning space objects to the Earth. *Space object* means any object launched or intended to be launched into outer space, including the component parts of such an object, and any device and its component parts used or intended to be used for launching an object into outer space. *Operator* means a natural or legal person who is responsible for the carrying out of space activities.[9]

Space activities may only be carried out subject to prior authorization by the Ministry of Economic Affairs and Employment.[10] The authorization may be issued on condition that the operator has the necessary technical and financial qualifications for carrying on space activities and that, according to a risk assessment, the space activity does not pose any particular danger to persons, property or public safety. Moreover, it is required that the operator strives to prevent the generation of space debris and adverse environmental impacts on the Earth, in the atmosphere, and in outer space, including a plan for terminating the activities in outer space; that the activities in outer space are compatible with national security interests, Finland's international obligations and Finland's foreign policy interests; that the operator meets the possible requirements for insurance; and that the operator complies with the rules of the International Telecommunications Union and export control legislation. Transfer of the space activity to another operator is subject to prior authorization by the Ministry and the same conditions for authorization.[11]

The Ministry of Economic Affairs and Employment maintains a registry of space objects.[12] The basic information on a space object is recorded in the registry and includes: the launching states, the name of the operator, the designator or registration number of the space object, the general function of the space object, the date and place of launch and the launch vehicle, and the basic orbital parameters, including nodal period, inclination, apogee and perigee. Besides space objects whose state of registration is Finland, in accordance with the Registration Convention, the register will contain information on space objects that are transferred to Finnish operators in cases where Finland is not considered a launching state.

The state has the right to recover from the operator compensation paid to an injured party.[13] For damages caused on the surface of the Earth or to aircraft in flight or its passengers or crew, the state has the right to recover the paid compensation from the operator even if the operator had not caused the damage deliberately or negligently. The maximum amount of the state's right of recourse in these cases is

[8] Section 3 of the Act on Space Activities.

[9] Section 4 of the Act on Space Activities.

[10] Section 5 of the Act on Space Activities.

[11] Section 11 of the Act on Space Activities.

[12] Section 6 of the Act on Space Activities.

[13] Section 7 of the Act on Space Activities.

60 million euros, unless the operator has failed to comply with the Act or the conditions attached to the authorization. For damages in outer space, the state has the right to recover the paid compensation to the extent that the operator would have been liable for the damage to the injured party under the national Tort Liability Act. In these cases, there is no limitation on the maximum liability.

The operator shall take out insurance against damage caused by the space activities to third parties.[14] The Ministry of Economic Affairs and Employment may refrain from requiring the insurance if the insurance of the launching company covers the operator's liability for damage caused by the space activities to third parties, or if, on the basis of the risk assessment of the space activities, the Ministry of Economic Affairs and Employment can accept the risk of damages on Earth, in the airspace and in outer space.

The Ministry of Economic Affairs and Employment supervises space activities through operators' obligation to inform the ministry of any changes in the space activities[15] and to report to the ministry annually on the status of the space activities.[16] The ministry has the right to obtain any information necessary for the supervision,[17] it can conduct necessary inspections of the premises and documents[18] and it can amend or withdraw the authorization if the operator has violated the provisions of the act or the conditions attached to the authorization.[19] A fine may be imposed to an operator carrying out space activities without authorization or neglecting certain obligations of the Act.[20]

The Act includes an obligation on the operator to ensure the safety of its space activities in all phases and to ensure that the persons responsible for space activities have the required knowledge and experience.[21] Even though there are no launch operations yet nor planned from the territory of Finland, it is stated that the safety of air traffic must be ensured if a space object is in the airspace of Finland.[22] Provisions on space objects found on Finnish territory are also included in the Act. Any found space object must be reported to the authorities and must not to be removed without permit.[23]

Provisions regulating space debris and environmental harm are described below.

The decree of the Ministry of Economic Affairs and Employment contains in particular provisions on what documents and other information must be submitted by the operator in the application for authorization and for supervision. The Act also

[14] Section 8 of the Act on Space Activities.

[15] Section 11 of the Act on Space Activities.

[16] Section 14 of the Act on Space Activities.

[17] Section 14 of the Act on Space Activities.

[18] Section 15 of the Act on Space Activities.

[19] Section 13 of the Act on Space Activities.

[20] Section 21 of the Act on Space Activities.

[21] Section 9 of the Act on Space Activities.

[22] Section 1, sub-section 3 of the Act on Space Activities.

[23] Section 16 of the Act on Space Activities.

specifies the level of risk that is considered acceptable when considering the need for third party liability insurance.

10.3 Obligation to Avoid Space Debris and Environmental Harm

When the Act was prepared, it was considered important to emphasise the sustainable use of outer space and avoidance of space debris.[24] Avoidance of unnecessary environmental harm and space debris is one of the conditions for authorization, which is then complemented by a specific section on the topic.

According to Section 5 of the Act, space activities may only be carried on subject to prior authorization by the Ministry of Economic Affairs and Employment. The Ministry may authorize space activities if the conditions specified in the section are met. One of the conditions is that the operator strives to prevent the generation of space debris and adverse environmental impacts on the Earth, in the atmosphere and in outer space in accordance with section 10. Furthermore, it is provided that the operator must have a plan for terminating the activities in outer space and for the related measures.

Section 10 of the Act contains provisions for environmental protection and space debris.

The first sub-section applies to the environmental impacts of the space activity. According to the paragraph, space activities shall be carried out in a manner that is environmentally sustainable and promotes the sustainable use of outer space. In its application for authorization, the operator shall assess the environmental impacts of the activity on the Earth, in the airspace and in outer space, and present a plan for measures to counter or reduce any possible adverse environmental impacts. Any nuclear or other radioactive materials used in the space object shall be specified in the application for authorization.

The second sub-section applies to space debris and states that the operator shall, in accordance with the recognised international guidelines, seek to ensure that the activities in outer space do not generate space debris. It is further specified in the paragraph that the operator shall in particular restrict the generation of space debris during the normal function of the space object, reduce the risks of breakage and collision of the space object in outer space, and strive to remove the space object from its orbit to a less crowded orbit or to atmosphere after it has completed its mission.

Space debris is not defined in the Act. In the explanatory memorandum for the Government proposal it is explained that space debris means, in accordance with

[24] This is also in accordance with the draft UN guidelines for the long-term sustainability of outer space activities. The latest version for the upcoming session of the Scientific and Technical Sub-Committee of COPUOS is available as UN-document A/AC.105/C.1/L.362/Rev.1.

general international definition, any non-functional space object and its parts, including non-functional satellites, upper-stages of launch vehicles and other loose particles in outer space.[25]

Recognised international guidelines refer to the Space Debris Mitigation Guidelines of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), the Inter-Agency Space Debris Coordination Committee (IADC) Space Debris Mitigation Guidelines, and the European Code of Conduct for Space Debris Mitigation, as well as relevant standards by the International Organization for Standardization (ISO). These are not specified in the Act or in the Decree but are mentioned in the explanatory memorandum. It was seen as important that the provision would cover also possible new international guidelines or other legal instruments. During the authorisation process, particular attention is paid to these guidelines by the Ministry. If measures to mitigate space debris are not considered adequate, authorization may be denied.

Even though the provisions on authorization, insurance and supervision are not applied to satellites of the Finnish defence forces, the provisions on environmental protection and mitigation of space debris apply to their satellites as well.

Further provisions on the environmental impact assessment and the measures necessary to avoid the generation of space debris may be given by a decree of the Ministry of Economic Affairs and Employment. Currently, the Decree states only that an operator shall seek to remove the space object to a non-crowded orbit or to atmosphere in 25 years after the end of its functional operating period.[26] It is to be noted that this provision is somewhat wider than for example the IADC space debris mitigation guidelines, which state that space objects should be removed from Low Earth Orbit (LEO) into atmosphere in 25 years but there are no specific post mission disposal measures from the geostationary orbit (GEO).[27] The working group, however, considered important that the same time limit is applied to removal of space objects from all orbits, if needed.

10.4 Active Space Debris Removal

The Finnish Act does not contain any provisions on active space debris removal. However, the intention of the working group was to enhance all possible measures to prevent, control and reduce the generation of space debris. As it was anticipated that most Finnish satellites would be small satellites operated on the crowded low orbits, the space debris issue was seen as especially critical.

[25] This is similar to for example IADC Space Debris Mitigation Guidelines and COPUOS space debris guidelines.

[26] Section 3 of the decree of Ministry of Economic Affairs and Employment on space activities.

[27] IADC Space Debris Mitigation Guidelines Section 5.3.

The working group recognized that, according to many recent studies, the population of space debris in Low Earth Orbit (LEO) would continue to grow even under strict implementation of all mitigation measures. Thus, even more active measures may be needed in the near future. As technology is still developing and there are no binding international rules concerning active removal measures, it was not yet possible to include in the Act any provisions on active space debris removal.

It was seen as important however, that when the technology develops and international rules progress, Finnish legislation would entitle the authorizing and supervising authority to require the operator to take measures that were not anticipated when then Act was drafted. Therefore, it is stated in Section 5 of the Act on Space Activities that an authorization for space activities may be made subject to conditions necessary for the safety or supervision of the activities. These could include measures needed to avoid and remove space debris.[28] If such conditions were not complied with, the authorization could be amended or withdrawn in accordance with Section 13 of the Act. Naturally, there is no licensing practice or examples of such conditions yet. Furthermore, as all current Finnish satellites are small satellites in LEO, they should return to atmosphere in due time without the need for active removal measures.

According to Section 5, point 4 of the second sub-section, in its application for authorization the operator must provide a plan for terminating the activities in outer space and for the related measures. Such plan should demonstrate that the space object will be safely removed from its orbit to re-enter the atmosphere, or transferred to a graveyard orbit after it has completed its mission. The re-entry or transfer may be done by the satellite itself or through a removal service.

Further provisions on measures needed for the control of space debris may be given by a Decree of the Ministry of Economic Affairs and Employment. Such provisions could include obligations or recommendations to undertake measures to actively remove space debris according to technological progress or international practice recommendations or guidance.

The intention of the working group was to define the scope of the Finnish Space Act so that it could also cover new types of space activities developed in the future including, for example, in-orbit servicing and active space debris removal. The present definition can therefore encompass launching and operation of a space object on orbit with the purpose of removing space debris. Such activity would be subject to authorization and supervision by the Ministry. It should also be noted that transferring space activities to another operator, which might be necessary for the purposes of debris removal, is subject to prior authorization by the Ministry and the new

[28] This was also one of the recommendations of "Active Debris Removal – An Essential Mechanism fro Ensuring the Safety and Sustainability of Outer Space, a Report of the International Interdisciplinary Congress on Space Debris Remediation and On-Orbit Satellite Servicing", pp. 44–45. UN document A/AC.105/C.1/2012/CRP.16 in http://www.unoosa.org/pdf/limited/c1/AC105_C1_2012_CRP16E.pdf (22.1.18).

operator must meet the conditions for authorization in accordance with section 5 of the Act.[29]

Sustainable use of space is one of the main research areas of the Finnish space sector. In particular, the Centre of Excellence on sustainable space[30] combines expertise from the Universities of Helsinki and Turku, Aalto University and the Finnish Meteorological Institute. The focus of its research is on radiation-tolerance for micro-satellites and containment of space debris. One of the missions of the first Finnish satellite Aalto 1 by Aalto University is to test the electrostatic plasma brake to bring down the satellite, and to demonstrate the usefulness of the plasma brake as a satellite deorbiting device.[31]

Any measure to actively remove space debris would probably entail further discussions on issues concerning, for example, the definitions of space object and operator, liability, insurance obligations and safety provisions. This might require amendments to and fine-tuning of the present Act and Decree.

10.5 Conclusion

One of the objectives of the Finnish Space Act was to draw attention to the importance of environmental issues in space activities. Operators are therefore obliged to avoid both environmental harm and the generation of space debris. It is also seen as important that the Ministry and other relevant authorities follow closely technological and legal developments so that the use of new measures not anticipated or regulated in the present Act and Decree can be taken into consideration and enhanced. Much of this work will be done in the COPUOS where Finland has applied for membership this year.

Another objective of the Act was to promote new business opportunities through space activities by new actors, especially small and medium-sized enterprises. The technical development of new measures to actively remove space debris might provide new possibilities for innovations to be used in debris removal, and even new businesses providing active debris removal services.[32]

[29] Section 11 of the Act on Space Activities.

[30] https://www.helsinki.fi/en/researchgroups/finnish-centre-of-excellence-in-research-of-sustainable-space.

[31] See more in http://aalto1.fi/aalto1_in_english.html and http://www.electric-sailing.fi/.

[32] Business Finland, the national innovation funding agency (formerly known as Tekes), is preparing a programme for New Space Economy. The New Space Economy programme will help start-ups to renew the space sector and manufacturing companies to seek growth, as well as enhance businesses that utilise space data. The programme aims to double the exports of participating companies by 2020, while achieving an annual turnover of at least EUR 600 million in services within the sector.

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Chapter 11
French Law Approach Around the Topic "Legal Implications/Aspects of Active Debris Removal (ADR")

Philippe Clerc

Abstract Active debris removal (ADR), which is broadly defined as an on-orbit service consisting in of removing space debris into a graveyard orbit or to an Earth return trajectory, is considered as a *Space Operation* under the French Space Operations Act of 3 June 2008 ("Loi n° 2008 -518 du 3 juin 2008 relatives aux opérations Spatiales" published in the French official gazette (JORF) on the 4th of June 2008.) (herein FSOA) which came into force on 10 December 2010.

As a preliminary remark, this legislation has been subject to a thorough analysis by Bernard Schmidt-Tedd and Isabelle Arnold (DLR) in a paper published under the ageis of ESPI, "The French Act relating to Space activities. From international law idealism to national industrial pragmatism" (ESPI Perspectives N° 11, August 2008. Available for free downloading from the ESPI website www.espi.or.at.).

11.1 Active Debris Removal Is a *Space Operation* Under the Scope of FSOA

ADR falls under the scope Article 1.3 of the FSOA, which provides that a "Space Operation" means "any activity consisting in *launching or attempting to launch an Object in Outer Space, or in ensuring the command of a Space Object* during its journey in Outer Space […], as well as during its return on Earth".

In its first Article, the FSOA defines *Space activities* and *Space Operators* subject to the French Government's acceptance and supervision.

In addition, for the legal purpose of establishing a clear hand-over of responsibility and attribution of potential liability towards third parties between successive

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operations, this legislation introduces definitions of *"Launching Phase"*, "*Command Phase*" (on-orbit) and "*Return to Earth Phase*".

In the "*Launching Phase*" the responsibility of the Launch Operator starts at the instant the launch operations become irreversible and ends with the separation between the launcher and the satellite, subject to more specific provisions contained, if necessary, in the authorization issued to the Operator (FSOA Art. 1 §4).

The "*Command Phase*" (FSOA Art. 1 §5) starts from the moment when the object to be put in outer space is separated from its launch vehicle and ends when the first of the following events occurs:

- when the final manoeuvres for de-orbiting and the passivation activities have been completed;
- when the operator has lost control over the space object;
- the *return to Earth* or the full disintegration of the space object into the atmosphere.

Thus, it is clear that an ADR operation takes place during the "*Command Phase"*.

11.2 Determination of the ADR's Space Operator Under FSOA

Taking now into consideration the relevant person or legal body governed by the law, in other words the *ratione personae* criterion, this act provides that the *authorization process* only applies to a ***Space Operator***. This status is, *ratione materiae*, reserved to any individual or corporate entity carrying out a ***Space Operation*** *under its own responsibility and in an independent manner* (FSOA Art. 1-2°).

Thus, the characterization of who is a *Space Operator* under this Act goes back to the assessment of its actual responsibilities in the achievement of a *Space Operation*. This qualification is the responsibility of the "*Administrative Authority*" issuing the relevant *authorisation or license*,[1] under the judicial and final control of the Council of State, as for any administrative or regulatory decision.

Basically, this definition of the *Operator*, resulted from extensive discussions during the preparatory work within the *Council of State*.[2] This led to the adoption of

[1] An *authorisation* is the basic title awarded for each single operation (launch or commanding a space object) while a *license* may cover common terms and conditions applied to several operations carried out by the same operator and/or using the same space system.

The licence regime is introduced in FSOA's Article 4, paragraph 3 as follows: "*Licenses* certifying for a determined time period that a space operator satisfies moral, financial and professional guarantees may be granted by the administrative authority competent for issuing authorizations. These licenses may also attest the compliance of the systems and procedures referred to in the first paragraph with the technical regulations set forth. Lastly, these licenses may be equivalent to authorizations for certain operations".

[2] Council of State report, from its Reports and Studies Section named "For a legal policy for Space activities", an appraisal study adopted by the General Assembly of the Council of State on 6 April

a short definition,[3] with an interpretation that has proven to be widely shared by all the stakeholders.

Accordingly, the designation of *Operator* applies to those who, at a given time, have effective control or command and the power to dispose of the spacecraft, in other words, the one who acts as the real decision maker, even if not being the owner, in particular when it comes to engaging the spacecraft's end-of-life manoeuvres. As a result, there can be only one Operator at a time, who shall be the only party responsible as the Authorization holder and, eventually, liable for damages caused to third parties by the space object under his control.

Based on the same logic, the Act has retained the possibility of multiple Operators acting "*in series*" in the command of the same space object. For instance, the *transfer of command* of a satellite to another Operator can be formally authorized, in a final or a reversible manner, once nominally positioned in-orbit. The successor Operator will be then solely and fully responsible in controlling all Operations under the Act authorization.

For instance, the *Administrative Authority*, namely the Minister in Charge of Research and Space affairs, supported by CNES as technical arm, may grant, subject to a prior compliant application by the prime Operator, an authorization or a global license allowing a transfer of responsibilities between a "*routine Operator*" ("*nominal Operator*") to a "*specialized Operator*" for the achievement of certain critical or hazardous maneuver(s), i.e. change of orbit positioning, docking, reparation, end of life… Such an authorization or license is reversible in allowing a reallocation of responsibilities, and associated third party liability, to the nominal or routine Operator once such critical manoeuvers have been properly achieved by the specialized Operator, according to the Administrative Authority's decision based on a CNES technical review.

This application procedure for the bilateral transfer of command, in all circumstances, affords the French government the opportunity: (i) to obtain from the Operator the necessary guaranties regarding the national and international commitments made by that foreign state as well as its legislation and practices regarding the safety of persons and property, the protection of public health and the environment, and liability indemnification , and/or (ii) to enter into negotiations direct with the appropriate state in order to agree on a specific solution.

Basically, in its 2006 report, the Council of State was mainly inspired by a contract law approach based on "*contract of enterprise or of service*"[4] under which a party (*prime contractor* or *service provider* or *maître d'oeuvre* or *prestataire de*

2006, published by La Documentation Française, 29–31 Quai Voltaire, www.ladocumentationfrancaise.fr, ISBN 2-11-0062005-3, see on the concept of Space Operator § 2.1.1.3.1, page 72 and 73.

[3] Ibid. footnote n° 4, Article 1.2° and 1.3° of the first draft legislation its Annexe 4, page 139.

[4] In French "contrat d'entreprise" or "contrat de louage de service" or "contrat de louage d'ouvrage d'ouvrage" as defined in the French Civil Code in article 1710 on "*louage d'ouvrage*" (contract for works) and specified on article 1779 et seq. "*louage d'ouvrage et d'industrie*" (*contracts for works and services*), including "*louage de service*" referred to in Art. 1779. 1° (*service provision contract*), "*voituriers*" (*contracts of carriage by land and water*) referred to in Art. 1779. 2° and "*marchés et devis*" (*contracts for works and estimates*) referred to in Art. 1779. 3°.

service) agrees to do something in consideration for a remuneration agreed by the other party (*contracting authority*, *client* or *customer*). Citing the definition of Alain Bénabent,[5] the Council of State underlined that such a contract means that the contractor *acts independently, without representing* of its client, in other words *without a subordinate relationship*.

In this respect, FSOA does not affect *subcontractors* who do not have autonomy of action or decision-making powers at critical moments, or *owners* such as financial or capital structures that are not involved in the Operations.

Consultations between the French Government, the Parliament and representatives of Space Operators and manufacturers during the law-making process (2007–2008), and later for the drawing-up of application rules (2008–2010), helped to develop the criterion of "independent manner". It resulted from such discussions that the characterization of Space Operator was to be reserved for the sole "effective and final decision maker" and, further, to the one having the real (or delegated) "animus domini" referring to a concept of property law that confers the right to have the thing, for example by alienation or by destruction.

It appeared indeed that from the administrative perspective, the *owner of the satellite would be ultimately presumed to be the Operator* <u>*in case of a confusing situation*</u> in the contractual or operational scheme or chain, whether arising or not from a deliberate willingness among the different stakeholders.

Basically, the difficulty of identifying the genuine Space Operator may arise with regard to the satellite's *end-of-life period*, at the time when decisions are made about starting disposal manoeuvres, or not. A *conflict of interest* may arise between the *economic user or owner of the satellite*, wishing to extend the working life of its asset, and the *effective technical Operator* that remains accountable to FSOA regulations and associated penalties. The question then is one of determining who will make independently the final decision.

Accordingly, following the same pragmatic approach, a subcontractor who unequivocally acts independently as an Operator may be qualified as such. For example, a satellite manufacturer that carries out the satellite *in-orbit positioning* manoeuvers pursuant to an *"In-Orbit delivery contract"* may be characterized as the actual Operator on behalf of its contractor; the latter may be the future satellite owner or its final nominal Operator.

From a private sector point of view, it is worth underlining that acting as an FSOA Space Operator without holding a prior authorization or licence may be heavily sanctioned, by:

- a fine of € 200,000 pursuant to FSOA Article 11.3°, it being understood that this sanction may be applied either to a natural person having French nationality or a juridical person (limited company) having its headquarters in France;
- an obligation to bear, if any, the expenses resulting from the appropriate measures taken by the *administrative authority*, or CNES, to limit the risks of damage

[5] Ibid foot note n°4, page 72. Alain Bénabet, "Contrat d'entreprise", J.-Cl. Contrats-distribution, fasc. 425, n°5.

due to that unauthorized Operation (FSOA Art. 9 second paragraph, Art. 8 and Art. 21 III);
- the refusal of any *guarantee* (FSOA, Art. 14) or *limitation of recourse action* (FSOA, Art. 15) from the French government with regard to indemnification of third parties in case of damage caused by such unauthorized Operation (i.e. the famous governmental coverage for damages over € 60 Million).
- the associate loss of 1/3 party insurance coverage for the same risks, between zero to € 60 M of damages.
- The risk of being unable to be further authorized as a Space Operator due to the lack of "moral, financial and professional guarantees of the applicant" with respect to the conditions provided for in FSOA Art. 4.

Thus, this criterion of "independent manner" proves to be the *stumbling block* of the FSOA's regime for the allocation of responsibility and liability. Such a condition is a prerequisite for the grant of a governmental authorization or licence, and to identify the person potentially liable for any damage caused by the Space Object as well as the beneficiary of the state guarantee.

Consequently, this criterion dramatically affects the organization of the contractual and financial framework between all stakeholders involved in a Space venture, particularly in an ADR Operation as discussed below.

11.3 Liability Toward Third Parties Resulting from ADR's Operations

The **liability burden** according to French law is set on the shoulders of the Space Operator who is responsible at the time of the generation of the damage.

Indeed, Article 13 FSOA provides that the Operator shall be ***solely liable*** for damages caused to third parties by the Space Operations which ***it conducts, as stated*** in the following conditions:

1° He shall be *absolutely liable* for damages caused on the ground or in airspace;
2° He shall be *liable only due to his fault* for damages caused elsewhere than on the ground or in airspace.

This distinction between liability fordamage on the ground and in airspace, and damage in-orbit is consistent with the UN Convention on International Liability for Damage caused by Space Objects of 29 March 1972. It is also rather similar to that of the French Civil Code.[6]

However, the FSOA adds that the Operator' liability may (only) be reduced or set aside if the fault of the victim is proven.

[6] Between Article 1240 on *"fault liability"* (old numbering, before 2016: Art. 1982) corresponding to FSOA's article 13.2°, and Art. 1242 on "liability for the actions of things" (old numbering, before 2016: Art. 1984) corresponding to FSOA's article 13.1°.

In addition, except in case of willful misconduct, the Space Operator's special liability under FSOA Art. 13 ends when all the obligations set out in the authorization or the licence as to its own phase of responsibilities are fulfilled, or at the latest 1 year after the date on which these obligations should have been fulfilled. The government shall be liable in the Operator's place for damages occurring after this period.

In practice, the determination of Operator liability toward third parties in an ADR does not present any particular difficulty since the *removed Space Object* is a *debris,* or a satellite *fully out of control or passive* when transported by the *"remover"*. In this case, the liability burden, as it relates to third party compensation will be sought first against the "remover Space Operator"(and not against the other eligible persons tied with the "removed" or "displaced" Space Object) and shall be based on the latter's "**fault"** (FSOA art 13. 2°), provided that it was acting independently and under its sole responsibility as discussed above.

The "remover" does not benefit from the French State **guarantee** for damage caused in orbit (FSOA art 15.2). However, the "remover" may benefit from a **limitation of the recourse action** from the French government (FSOA, Art 14.2°—capped at € 60 M€ actually) when the victim obtained compensation from this government under the 1972 Convention on International Liability for Damage caused by Space Objects.

The pursuit of the effective Operator who is liable to third parties may be more difficult in a situation where the Space Object to be displaced is not yet a Space *debris* and where its own *guardian or Operator, and* a fortiori *the owner of the removed space object* has the capacity and the willingness to participate partly in its ADR in conjunction with the "*remover*". Such extra-routine manoeuvers by nature were not included in the original authorization or license regarding such "displaced" Objects, and require specific amendment to be obtained previously from the administrative authority. It is thus advisable for the parties to set out clear terms and conditions for the ADR Operation in their own agreement, and to submit their implementation plan to the relevant administrative authority for prior authorization.

In the case of an ADR between French and foreign Operators having their Space Objects registered in different jurisdictions, the issue with regard to FSOA is to obtain the right authorization on *transfer of command* according to Article 3.[7]

[7] **Article 3** (*Authorization for transferring command of Space objects or "Autorisation des transferts d'objets spatiaux"*).

– The transfer to a third party of the commanding of a Space object which has been authorized pursuant to the terms of the present act is subject to prior authorization from the administrative authority.
– Pursuant to the provisions of paragraph 3 of Article 2, any French operator intending to take the control of a Space object whose launching or control has not been authorized under the present act shall obtain to this end a prior authorization from the administrative authority.

Indeed, this article has expressely achnowledged the possibility of transferring command between French and foreign Operators relating to systems already placed in orbit. This transfer shall be subject in both cases to a dedicated authorization and license under FSOA:

- Paragraph 1 of Article 3 refers to the transfer of command from a French Operator, holding an authorization under FSOA, to a foreign Operator intending to work under foreign jurisdiction, with the issue of transferring or not, all or part, of the launching state's liability compensation to the recipient state, as provided in Article V.2 of the 1972 UN liability convention, without prejudice to the rights of third party victims under Article IV.
- The second paragraph applies to a French Operator intending to take the control of a (foreign) Space Object whose launching or control was not authorized under FSOA, in other words, the takeover of a space system previously subject to a foreign jurisdiction.

11.4 Liability of Persons Taking Part in the ADR' Space Operation or in the Production of a Space Object

The **liability** regime in case of damage among participants in an ADR operation is defined in FSOA Art. 20. This article set up, by defaut, a systematic ***waiver of claim global system***, or ***exclusion of guarantee*** expanded by a ***hold harmless regime*** between *all participants taking part in an authorized Space Operation* (FSOA, Art.20). Actually, despite the reciprocal application of this clause among participants, it ultimately protects the effective Space Operator liable for the damage caused. However, parties may expressly stipulate contrary provisions but only with respect to a *damage caused on commanding a Space Object in-orbit*. Insofar, such exception to the common regime of waiver of claim may be acknoledged in an ADR's service contract between the "remover Space Operator" and the "removed eligible party".

Regarding the question of identifying who are the "persons taking part in the Space Operation" reference is made to Article 1.6° which clearly defines "third parties". Indeed, the term "third party to a Space Operation" means any natural or juridical person *other than those taking part in the Space Operation* or in the production of the Space Object(s) the launch or command of which is part of the Operation. In particular, the Space Operator, its contractors, its subcontractors and its customers, as the contractors and subcontractors of its customers, are not regarded as third parties". The latter are therefore considered as taking part in the authorized operation.

11.5 Conclusion and Perspectives

We may assess that the FSOA provides a solution to legally secure ADRs provided that such Operations involve at least a French Space Operator or a registrated Space Object.

An issue that remains is to assess the extent to which Article 20s exclusion of liability could extend, on the one hand, to persons involved in *quasi-contracts,* as provided for in the traditional theory of "*negotiorum gestio*" (or "*gestion d'affaire*" or "*quasi-contrat*")[8] or, on the other hand, to persons acting as *occasional or volunteer contributors to a public service mission*[9] on behalf of related governments.

This issue, however, exceeds the scope of this paper which is devoted to positive law in France as concerns ADR's. We may conclude that it is food for thought about the future direction and work of law-makers, either on national legislation or on new international instruments.[10]

[8] The legal regime of "negotiorum gestio", is derived from "Roman law", and was codified under the French Code Civil. It can be defined as a willful interference, by an intervener (or manager or in French "gérant"), in the management of business or private affairs of others made in the interest of the latter (the beneficiary or business master, or in French "maître de l'affaire") and without the beneficiary's knowledge or without opposition from him or her, obliging such beneficiary to honor (or accept) the commitments made by the intervener and to cover the latter's costs, expenses or disbursements, provided that the management was useful.

This "negotiorum gestio" situation may arise when somebody, without express contract or mandate, ensure protection of property and human safety of others, for instance on firefighting, victim's aid or any rescue but also to prevent ordinary material damage as fixing water leaks, or initiating conservative repairs or protection shields against hazards.

[9] The French Administrative Law, provides a similar framework than *negotiorum gestio* on behalf of *"occasional or volunteer contributors to a public service's mission*". Such public service's initiatives, also consists in property's protection, human safety of others, but also of general interest services provisions, such as public works in organizing public celebration, sports, cultural or educational events, academic lectures… as services usually under the responsibility of civil servants or public officers.

Indeed, according to the well-established Council of State case-law such volunteer contributors to a public service's mission, may be compensated for accident damage that may happen to them while accomplishing their general interest mission. They may also be reimbursed of their mission expenses. In addition, these private contributors may engage directly the State liability for damage caused to third parties during their voluntary mission of general interest.

[10] Potential application of "negotiorum gestio" theory to ADR's operation within a new dedicated international framework has been envisaged by Doctor Guoyu Wang in a well-founded paper named "Legal Challenges to On-orbit Servicing and a China's perspective" presented on September 2017 during the International Astronautical Congress (IAC) held in Adelaide, Australia.

Dr. Guoyu Wang, Beijing Institute of technology(BIT), China. Co-author Mr. JIE YUAN, China. "Legal Challenges to On-orbit Servicing and a China's perspective", IAF/IISL/IAC 2018, Adelaide, Australia, on 25–29 September, n°IAC-17, E7,6-E3.5,4, x41849….

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